February 17, 1961

electronics

Low-cost broadband antenna for uhf telemetry uses modular disk-rod end-fire elements, has low sidelobes and low inertia. *See p 140*

Tunnel diode r-f amplifier uses stripline techniques. *See p 120*

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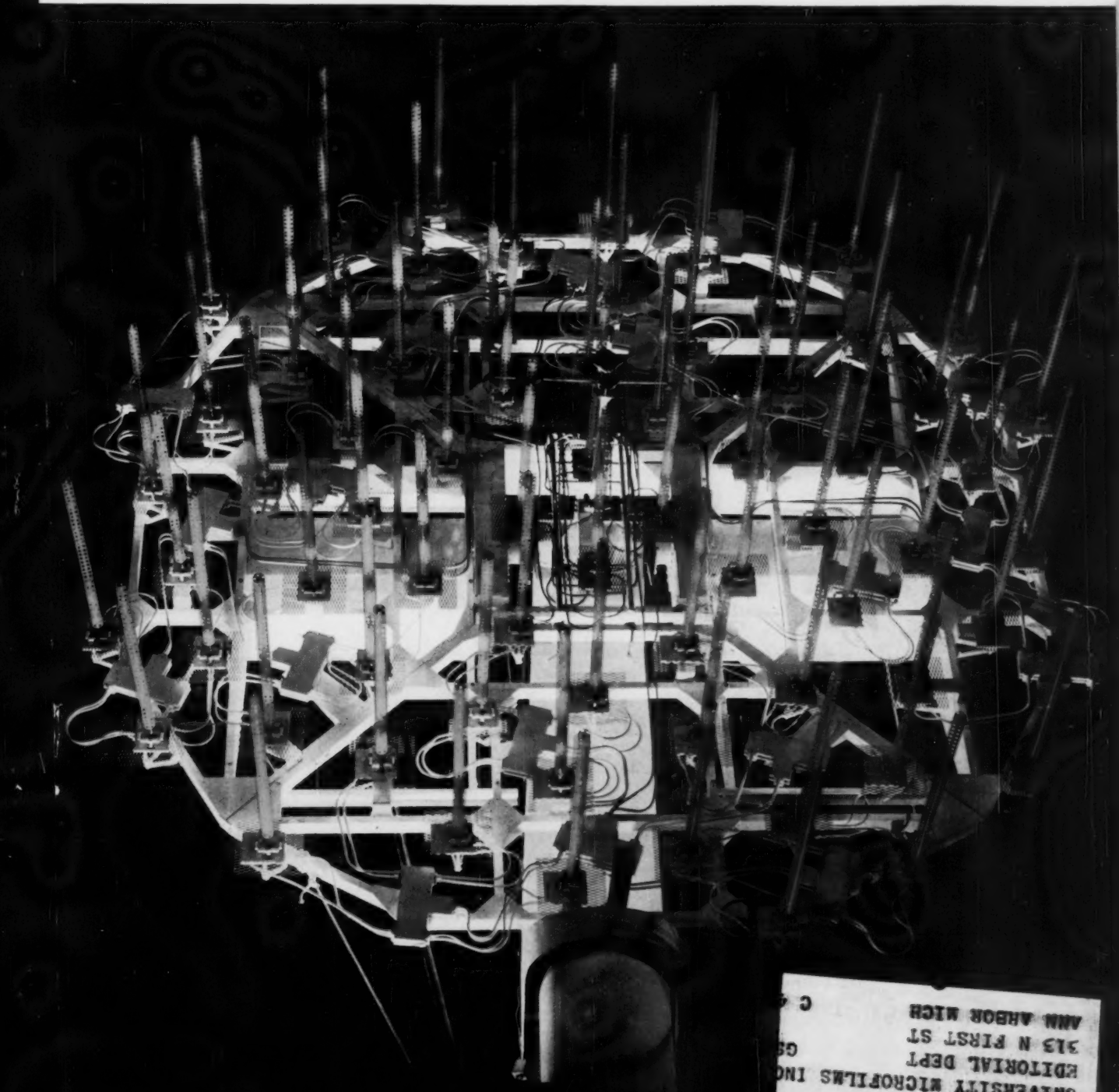

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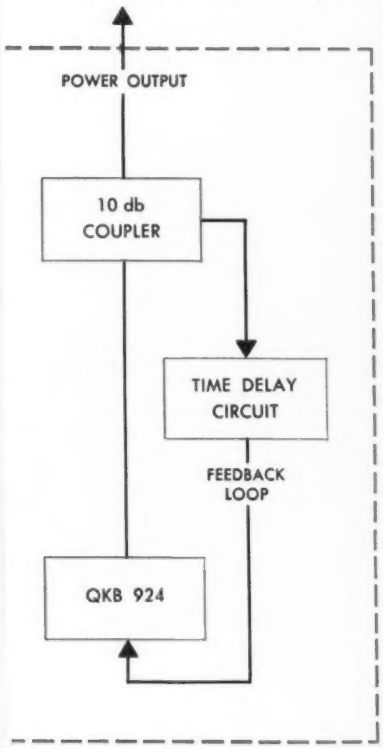
QKB 924

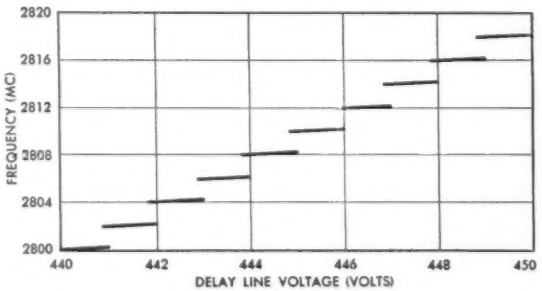


New Raytheon master oscillator assures extreme stability in frequency diversity transmitters

The QKB 924 voltage tunable "O" type backward wave oscillator with the feedback circuit shown above provides a highly stable master driver–local oscillator for S-Band MOPA chains.

External feedback through a delay line provides a 10:1 or more increase in frequency stability–performance that is particularly suitable for frequency diversity MTI applications. The frequency vs. voltage curve of the circuit is essentially flat at discrete steps over the entire 2,700 to 3,200 Mc range. Power output is typically 100 milliwatts with a delay line tuning voltage of 350 to 700 volts. Models are also available at frequencies through X-Band.

Write for detailed application information to Raytheon Company, Microwave & Power Tube Division, Waltham 54, Massachusetts. In Canada: Waterloo, Ontario.



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MICROWAVE AND POWER TUBE DIVISION

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NEW
20 AMP 0-34 VDC
Regulated POWER SUPPLY joins

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Dual-deck, swing-out back construction provides simple and fast service access without the need to remove unit from rack. All major component terminals are accessible from rear.

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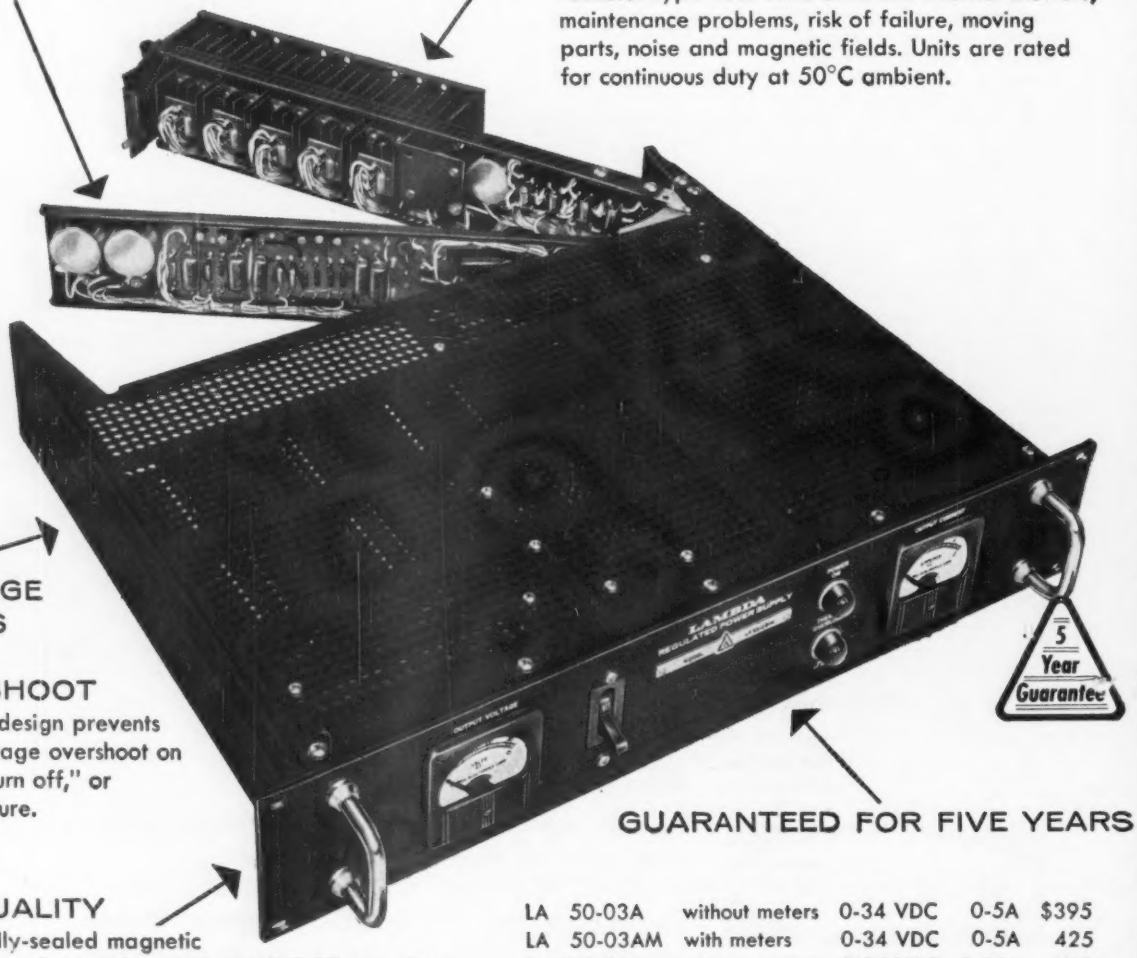
Advanced design and special, highly efficient, radiator type heat sinks eliminate internal blowers, maintenance problems, risk of failure, moving parts, noise and magnetic fields. Units are rated for continuous duty at 50°C ambient.



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GUARANTEED FOR FIVE YEARS

MIL QUALITY
Hermetically-sealed magnetic shielded transformer designed to MIL-T-27A quality and performance. Special, high-purity foil, hermetically-sealed long life electrolytic capacitors.

LA 50-03A	without meters	0-34 VDC	0-5A	$395
LA 50-03AM	with meters	0-34 VDC	0-5A	425
LA 100-03A	without meters	0-34 VDC	0-10A	510
LA 100-03AM	with meters	0-34 VDC	0-10A	540
LA 200-03A	without meters	0-34 VDC	0-20A	795
LA 200-03AM	with meters	0-34 VDC	0-20A	825

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NO BLOWERS

5 AMP 3½" HIGH
10 AMP 7" HIGH
20 AMP 10½" HIGH

Patent Pending

Lambda LA Series Power Supplies are compact, convection cooled and rated for continuous duty at 50°C ambient temperature.

LAMBDA Transistorized 5 and 10 AMP LA Series

COMPLETE SPECIFICATIONS OF LAMBDA LA SERIES

DC OUTPUT (Regulated for line and load)

Model	Voltage Range[1]	Current Range[2]	Price
LA 50-03A	0-34 VDC	0- 5A	$395
LA 50-03AM	0-34 VDC	0- 5A	$425
LA100-03A	0-34 VDC	0-10A	$510
LA100-03AM	0-34 VDC	0-10A	$540
LA200-03A	0-34 VDC	0-20A	$795
LA200-03AM	0-34 VDC	0-20A	$825

[1]The output voltage for each model is completely covered in four steps by selector switches plus vernier control and is obtained by summation of voltage steps and continuously variable DC vernier as follows:

MODEL	VOLTAGE STEPS
LA 50-03A, LA 50-03AM —	2, 4, 8, 16 and 0-4 volt venier
LA100-03A, LA100-03AM —	2, 4, 8, 16 and 0-4 volt venier
LA200-03A, LA200-03AM —	2, 4, 8, 16 and 0-4 volt venier

[2]Current rating applies over entire output voltage range

Regulation (line) . . . . Better than 0.05 per cent or 8 millivolts (whichever is greater). For input variations from 100-130 VAC.

Regulation (load) . . . Better than 0.10 per cent or 15 millivolts (whichever is greater). For load variations from 0 to full load.

Transient Response (line) . . . . . Output voltage is constant within regulation specifications for step function line voltage change from 100-130 VAC or 130-100 VAC.

Transient Response (load) . . . . Output voltage is constant within regulation specifications for step-function load change from 0 to full load or full load to 0 within 50 microseconds after application.

Internal Impedance . . . LA 50-03A less than .008 ohms
LA100-03A less than .004 ohms
LA200-03A less than .002 ohms

Ripple and Noise . . . . . Less than 1 millivolt rms with either terminal grounded.

Polarity . . . . . Either positive or negative terminal may be grounded.

Temperature Coeffiicent . . . . . 0.025 %/°C

AC INPUT . . . . . 100-130 VAC, 60 ± 0.3 cycle[3]
LA 50-03A . . . 360 watts[4]
LA100-03A . . 680 watts[4]
LA200-03A . . 1225 watts[4]

[3]this frequency band amply covers standard commercial power lines in the United States and Canada.
[4]with output loaded to full rating and input at 130 VAC.

AMBIENT TEMPERATURE AND DUTY CYCLE . . . . . Continuous duty at full load up to 50°C (122°F) ambient.

OVERLOAD PROTECTION:

Electrical . . . . . Magnetic circuit breaker front panel mounted. Special transistor circuitry provides independent protection against transistor complement overload. Fuses provide internal failure protection. Unit cannot be injured by short circuit or overload.

Thermal . . . . . Thermostat, manual reset, rear of chassis. Thermal overload indicator light front panel.

INPUT AND OUTPUT CONNECTIONS . . . . . Heavy duty barrier terminal block, rear of chassis. 8 foot, 3 wire detachable line cord.

METERS . . . . . Voltmeter and ammeter on metered models.

CONTROLS:

DC Output Controls . . Voltage selector switches and adjustable vernier-control rear of chassis.

Power . . . . . Magnetic circuit breaker, front panel.

Remote DC Vernier . . . Provision for remote operation of DC Vernier.

Remote Sensing . . . . . Provision is made for remote sensing to minimize effect of power output leads on DC regulation, output impedance and transient response.

PHYSICAL DATA:

Mounting . . . . . Standard 19" Rack Mounting

Size	LA 50-03A	3½" H x 19" W x 14⅜" D	
	LA100-03A	7" H x 19" W x 14⅜" D	
	LA200-03A	10½" H x 19" W x 16½" D	
Weight	LA 50-03A	55 lb Net	85 lb Ship. Wt.
	LA100-03A	100 lb Net	130 lb Ship. Wt.
	LA200-03A	140 lb Net	170 lb Ship. Wt.

Panel Finish . . . . . Black ripple enamel (standard). Special finishes available to customers specifications at moderate surcharge. Quotation upon request.

Send for complete Lambda Catalog.

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515 BROAD HOLLOW ROAD, HUNTINGTON, L. I., NEW YORK 516 MYRTLE 4-4200

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electronics
Feb. 17, 1961 Volume 34 Number 7

Published weekly, with Electronics Buyers' Guide and Reference annually, as part of the subscription, by McGraw-Hill Publishing Company, Inc. Founder: James H. McGraw (1860-1948).

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Executive, editorial, circulation and advertising offices McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Telephone Longacre 4-3000. Teletype TWX N.Y. 1-1636. Cable McGrawhill, N.Y. Printed in Albany, N. Y.; second class postage paid.

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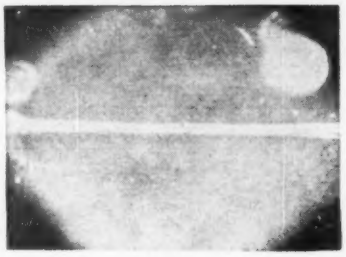

DOMAIN BEHAVIOR. Accompanying photo shows an irreversible N-state domain formed by applying and removing a transverse field from a film that was initially magnetized to the P state. This concept can be the basis of a nondestructive memory, as explained by J. W. Hart of Burroughs in his article beginning on p 126.

OPTICAL MASERS. One of the most significant developments for electronics in the past year was the optical maser, a development that opens a vast new range of the frequency spectrum for communication applications. One company (Bell Labs) has already impressed a telephone conversation on an infrared beam experimentally. Such applications as space communications and studies of basic physical phenomena look particularly promising. On p 31, Assistant Editors Wolff and Lindgren, who have been following maser developments since last summer, sum up some of the recent work.

IRRADIATION. Many times, in this business of gathering and reporting news, the facts that *aren't* said often make a story. This week there's a good example of this on p 28.

Few people are speaking for the record but—for the printed record—New England Editor Maguire reports exclusively that production-line diodes are being irradiated. And this has improved their switching time, an important development. Maguire first got wind of this story last year (see ELECTRONICS, p 11, Sept. 30, 1960). He has trailed it ever since. Some key companies still aren't releasing information. But enough facts are known to give you this week's report. There are many aspects to the story, not the least of which is this: radiation, a threat to many components in space, may be helpful on the ground.

Coming In Our February 24 Issue

SYSTEMS. The variety of interesting feature material to appear next week includes: designing sensing systems with semiconductor strain gages by R. E. Talmo of Micro Systems, Inc.; measuring paramagnetic material thickness by R. Dick of General Electric; and designing phantastron circuits using transistors by N. C. Hekimian of the Defense Department.

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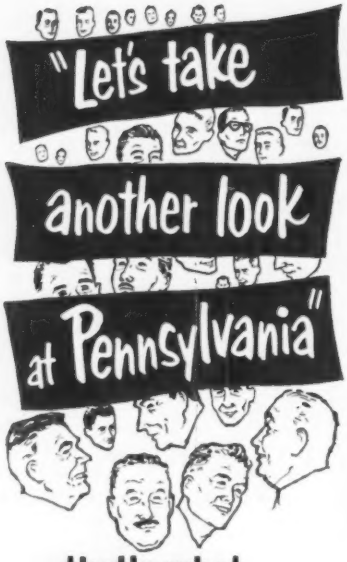

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COMMENT

Wireless Microphone

This is with reference to an article entitled "Tunnel Diode F-M Wirelesss Microphone" appearing on p 93 of your Nov. '60 edition . . . on use of a wireless microphone in the f-m band (88-108 Mc).

The band 88-108 Mc is allocated exclusively to the f-m broadcasting service. As the device described in the article is not intended or suitable for operation in that service it could not be licensed. These frequencies, moreover, are not available for use under Part 15, Subpart E, of our rules covering unlicensed operation of low-power communications devices (47 CFR Pt. 15). Unless operation of the device in question were covered by an experimental license under Part 5 of our rules, such operation would constitute a violation of the Communications Act of 1934 as amended, and Commission rules.

Frequencies available for operation of low-power communications devices are specified in sections 15.201 and 15.206 of our rules (47 CFR 15.201 and 15.206).

Section 15.201, *Frequencies of Operation*, says: (e) A low-power communications device may be operated on any frequency in the bands 10-490 Kc, 510-1,600 Kc and 26.97-27.27 Mc; (b) Other frequencies above 70 Mc may be used for operations of short duration.

Section 15.206, *Operation Above 70 Mc*, says: A low-power communications device may be operated on any frequency above 70 Mc, provided it complies with all of the following conditions: (a) operation is limited to one second duration and to occur not more than once in 30 seconds; (b) The radiated field on any frequency from 70 Mc to 1,000 Mc does not exceed the limits specified for receivers in Section 15.62; (c) The radiated field on any frequency above 1,000 Mc does not exceed 500 microvolts per meter at a distance of 100 ft; (d) The device is provided with means for automatically limiting operation within the time restrictions specified in this section.

Operations under Part 15 must also comply with the radiation limits and other technical requirements set forth therein, and the device must be tested and certified as complying prior to use.

A wireless microphone may be licensed for operation in any of the licensed services if it operates on frequencies allocated to that service, meets the other technical requirements of the service in question, is used for a purpose recognized by that service, and if the proposed licensee meets the legal, technical and financial requirements for operation in that service.

BEN F. WAPLE

FEDERAL COMMUNICATIONS COMMISSION

WASHINGTON, D. C.

Author Wen-Hsiung Ko replies:

. . . I have reviewed the literature and the FCC regulations. Truly, before I read over the FCC regulations carefully, I had the impression that if the signal is weak enough so that it is not detectable beyond 500 ft, one can operate it without a license. In fact, I found several articles describing similar devices using transistors operating in the same frequency band . . .

After checking the FCC rules, my comments are:

The reported device is an experimental unit to demonstrate the feasibility and to report the design considerations. The device was made to operate at this frequency band principally because of the convenience in obtaining receiving equipment.

This device may be designed to operate at any frequency below a few gigacycles by changing the tank-circuit elements in the usual manner.

Any reader that wishes to adopt this for his special use should check the FCC regulations to select a proper frequency and design the device accordingly. Any manufacturer that intends to fabricate such a device should check both the FCC regulations and the patent literature (a patent application is being filed).

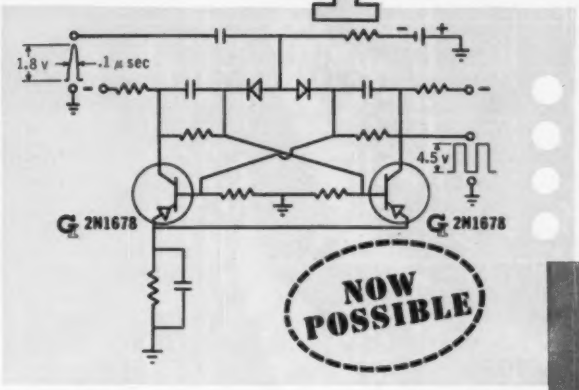
I suggest that ELECTRONICS call attention to the fact that this device is an experimental unit and for practical applications the user should conform to FCC rules . . .

WEN-HSIUNG KO

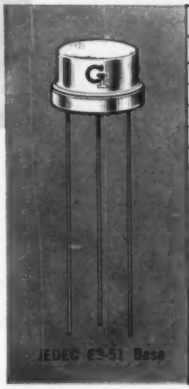
CASE INSTITUTE OF TECHNOLOGY
CLEVELAND, O.

General Instrument Semiconductor... Design Breakthrough

NEW GI 2N1678 "DYNAMIC DRIFT"



High Voltage
High Speed
Saturated Circuitry
At Low Cost



2N1678 PNP Germanium "Dynamic Drift"

Parameter	Conditions	Min.	Typ.	Max.
T_s		−65°C		+85°C
P_c	$T_a = 25°C$			120 mw
V_{CES}	$I_c = 100\ \mu a$	60 v		
V_{CBO}	$I_{CBO} = 25\ \mu a$	60 v		
V_{EBO}	$I_{EBO} = 100\ \mu a$	4 v		
h_{fe}	$I_c = 20$ ma; $V_{CE} = 0.25$ v	25	40	
I_{CBO}	$V_{CB} = 10$ v			5 μa
V_{at}	$I_c = 20$ ma; $V_{CE} = 0.25$ v			0.6 v
f_{hfb}	$I_E = 1$ ma; $V_{CB} = 5$ v	25 Mc	35 Mc	
f_{hfe}	$I_E = 1$ ma; $V_{CE} = 10$ v		50 Mc	
h_{ib}	$I_E = 1$ ma; $V_{CE} = 5$ v; $f = 1$ kc		30 Ω	
h_{ob}	$V_{CB} = 5$ v; $I_c = 1$ ma; $f = 1$ kc		0.5 μ mho	2 μ mho
C_{ob}	$V_{CB} = 5$ v; $I_e = 1$ ma; $f = 5$ Mc		3.5 pf	5 pf
$t_r + t_s$	$I_c = 20$ ma; $I_{B1} = I_{B2}$		0.4 μ sec	
$t_f + t_s$	$= 1$ ma; $R_L = 1K$		0.4 μ sec	

General Instrument proudly presents the 2N1678 "Dynamic Drift"... ideally suited for high speed, high voltage saturated circuit applications. The 1 Mc bistable multivibrator, above, is only one example of the multitude of applications for this attractively-priced transistor family.

Life test data proves reliability of the new General Instrument 2N1678 "Dynamic Drift". Close quality control guarantees extremely high electrical uniformity, shipment to shipment.

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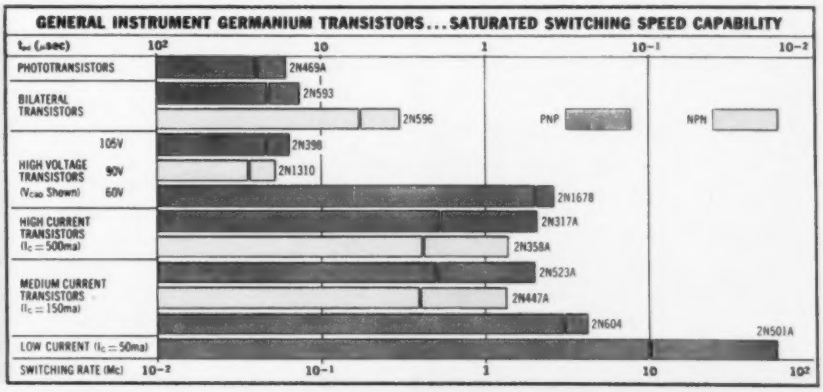
General Instrument is your major source for high quality computer semiconductors . . . *transistors*, as well as *companion diodes, rectifiers* and *logic encapsulations* for every type of circuit application. The transistor families shown below indicate the broad range of superior quality units offered by General Instrument.

Write General Instrument for complete engineering and life test data, design curves, and typical circuitry which takes advantage of the unique combination of characteristics offered by the new GI 2N1678. Data is available, of course, on our full line of computer semiconductors. Our engineers will gladly discuss your specific circuit requirements.

All speeds shown have been attained with conventional saturated circuitry. Total bar length represents rate (period) using speed-up capacitors; broken bar indicates maximum speed without capacitor.

Representative transistors shown are alloyed-junction devices. Types 2N501A, 2N604, and 2N1678 are MADT, Drift, and High-Voltage Drift, respectively.



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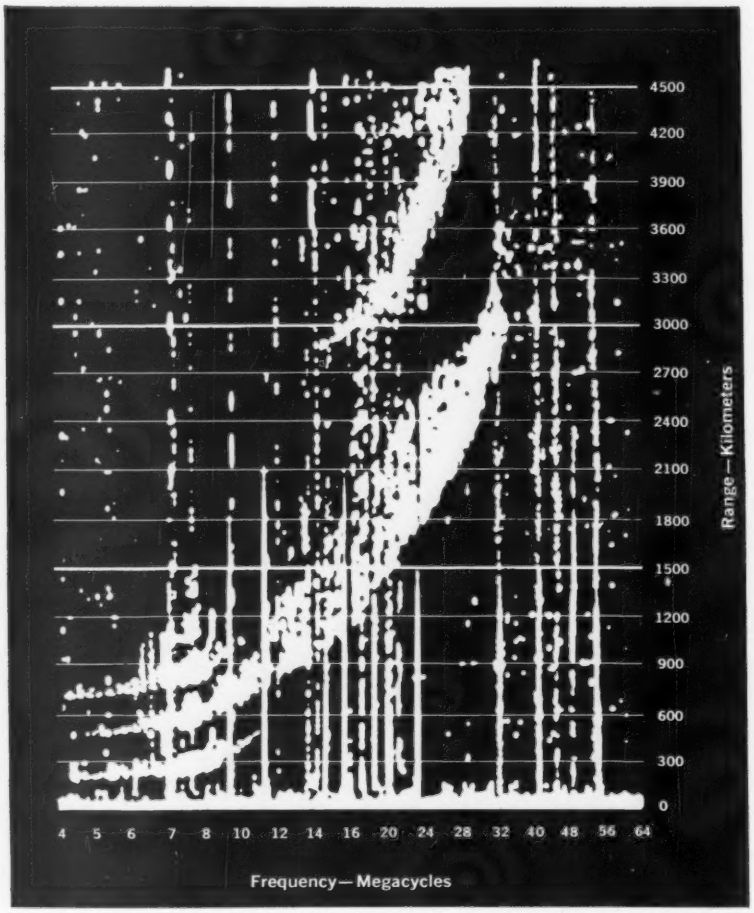
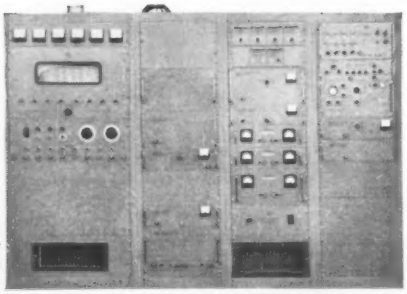


Typical oscilloscope record shows vertical incidence and backscatter returns using G/A Model 902



Sounder and G/A Pulse Distributed Power Amplifier.

The G/A 902 step-frequency ionosphere sounder is a multi-channel electronically-stepped high-power transmitter/receiver operating in the h-f band. 160 frequencies, from 4 to 64 megacycles, are derived from a single stable reference, and are electronically selected at rates up to 50 frequency changes per second. Operation is entirely electronic—there are no mechanical switches or tuning devices. Associated power amplifiers are available with pulse power outputs up to 100 kw.

Research Applications: Because of its simultaneous time and frequency resolution capabilities, this sounder is especially suited for observing auroral ionization, artificial ion clouds and ionized meteor trails. Other research applications include the observation of traveling disturbances at either oblique or vertical incidence.

Communications Applications: This sounder can be used with a steerable or fixed antenna to provide a continuous and essentially instantaneous display of the coverage area for one-hop ionospheric transmission. Two-hop and even higher order modes are displayed a substantial portion of the time.

For direct measurement of path loss, two or more sounders can be synchronized to provide an instantaneous display of path loss and/or path delay vs. frequency between circuit terminals.

A thirty-five page Granger Associates report gives you full specifications and operating principles on the sounder and related information on antenna systems. We'll be happy to send you a copy —airmail.

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ELECTRONICS NEWSLETTER

Federal Support of R&D To Reach $9.1 Billion in 1961

FEDERAL OBLIGATION for the support of scientific research and development in fiscal 1961 will reach $9.1 billion, the National Science Foundation estimated last week. Estimate includes $8.5 billion for R&D projects and $600 million for new R&D plant. Ten percent of the project money will go for basic research.

Total for 1961 is $500 million over the estimated obligation for fiscal 1960 and $1.8 billion more than the funds obligated in fiscal 1959. In 1960, only about $1.9 billion of the obligated funds were committed.

Department of Defense, Atomic Energy Commission and National Aeronautics & Space Administration are expected to administer about 90 percent of the R&D money. Physical sciences—including mathematical and engineering sciences—account for better than half the R&D expenditure. Educational institutions and federal agencies take about three fourths of the allocations; about 15 percent of the money goes to profitmaking organizations.

Infrared Communications Reach Out 20 Miles

COMMUNICATIONS SYSTEM called Maxsecom—for maximum security communications—has been announced by Minneapolis-Honeywell's aeronautical division. The system uses modulated infrared energy beamed from handheld "guns" which must be aimed at each other. Larger models currently in production have tested out at ranges up to 20 miles; handheld units reach three miles.

System is relatively immune to interference or detection except when the beam is directly intercepted. It was developed for military, police and civil-defense use.

Optical assembly includes lamp housing, condensing lens system, germanium modulator unit, lead-sulfide detector and collecting optics. Weight of the transceiver is less than ten pounds. Infrared is produced by a tungsten filament lamp, collected and focused on the modulator face. Voice signals from a microphone modulate the ir carrier. Outgoing infrared is collected by the lens and refracted into a tight beam. Common circuits are used to amplify the microphone output to the modulator and the received signal from the detector.

British Electronics Industry Reaches $1.4 Billion

ELECTRONICS INDUSTRY in Great Britain is producing $1.4 billion worth of equipment annually, and exports are running five times the 1950 level. This report was made last week by L. T. Hinton, chairman of Britain's Electronic Engineering Association.

Hinton said exports totaled $78.4 million in 1960 despite "severe competition—and not always strictly economic competition." Gross output of electronic capital goods was about $490 million, an increase of 150 percent in ten years.

He suggested that the outstanding technical achievement of 1960 was the development of a blind landing system called Autoland, which permits planes to set down without help of a pilot. System has been tested by the Ministry of Aviation, is being evaluated in the U. S. and on the continent.

New Computer Designed To Use Automatic Codes

IN NEW YORK this week, Burroughs Corporation announced a new computer system, called B5000, which was designed from the ground up to use Algol and Cobol compiling systems. The two automatic programming developments accept data respectively in algebraic notation and business English, drastically reduce programming complexity.

The B5000 uses transistor circuits operating at the conventional speeds of today's computers, but has a generalized logic that permits more flexible use of the automatic codes. Modular design permits expansion from minimum system to large computer complex without reprogramming. System also incorporates sophisticated maintenance and servicing aids.

Research Program Probes Behavior of Plasma

CASE INSTITUTE of Technology in Cleveland has set up a research program in plasma physics which hopes to see seeded plasmas playing a major role in production of electrical energy by 1966.

Also being investigated: radio transmission in space, specialized plasma amplifiers and oscillators for space probes, use of electrical fields to control plasmas expelled from spacecraft in order to derive propulsion power. Main object is to gain fundamental insights into plasma behavior.

Case scientists point out that power plants produce small amounts of ionized gas as a byproduct of burning. Liberated energy can be transformed directly to electricity if the conducting gases are passed through a magnetic field. Flame seeded with compounds of the alkali metals can produce even higher levels of energy. Big problem is finding metals which can resist corrosion from alkali compounds and survive high temperatures.

1960 Sales: Tubes Down, Radio and Television Up

FINAL TALLIES of sales in some electronic product areas were released last week by the marketing data department of Electronic Industries Association.

The EIA figures show factory sales of both tv picture tubes and receiving tubes were off from 1959 figures. Picture-tube sales totaled 9,013,671 in 1960, off 508,875; revenue totaled $180,832,131, off $2,939,791. Receiving tubes sales were 393,055,000, off 39,881,000 units; revenue declined $37,130,000 to $331,742,000.

Sales of radio sets, spurred by 2.4 million in Christmas purchases, reached 10,705,128 for 1960, the high for any year since 1948. Also

boosted by Christmas-season purchases, consumer sales of tv sets reached 5,945,045 for 1960, which was 196,369 more than 1959 and the best total since 1957.

Meeting to Report On Pure Semiconductors

INTERNATIONAL CONFERENCE on ultrapurification of semiconductors will attract scientists of seven nations to Boston April 11-13. The meeting, sponsored by the Air Force, will stress metallic semiconductors, is interested in purities of better than one part in a million.

A third of the 39 papers will be presented by researchers from Poland, Germany, France, England, Japan and India. No papers are scheduled from Soviet scientists, but several USSR representatives are expected to attend. Sessions will cover chemical preparation and purification, detection of trace impurities, physical preparation, and measurements.

Plasma Diode Converts 4,500 F to Power

PLASMA DIODE designed to use the heat present in the center of reactor fuel elements for direct conversion to electricity was announced last week by General Electric's atomics lab in California. Experimental unit uses cesium gas and a cathode containing uranium, operates on the core heat—about 4,500 F. It is expected to increase electrical output from nuclear power stations at small extra cost.

Present converters produce 20 watts per sq cm, are a long way from being practical units. GE feels that experimental work now underway will probably go into prototype test in five years, may be working in central-station plants by 1970.

Space Telemeter Aids Dental Research

AT CHICAGO DENTAL SOCIETY's midwinter meeting last week, Col. A. A. Brewer of the USAF School of Aviation Medicine demonstrated a small telemetering unit built into dentures to broadcast data on bite contacts and malocclusions.

Circuit was adapted from a unit developed to transmit mouse heartbeats from experimental animals in orbit. The device includes a two-transistor multivibrator at 40 Kc, transmits a record of selected tooth contacts. Signals are picked up by a receiver-amplifier hooked to a pocket watch which is modified to serve as an event counter.

Purpose of the experiments is to discover how people chew, and to find the best substitute for lost teeth. Earlier unit had wire leads from the mouth; present system can be hooked to a tape recorder to record grinding while subjects sleep. Coming soon: a transmitter the size of a collar button which can be installed in fixed bridgework.

Epitaxial Silicon Varactors Operate Above 100 Gc

MICROWAVE-RANGE silicon varactor diodes with cutoff frequencies in the 150-Gc range at −45 v breakdown voltage have been grown epitaxially by Sylvania. Conventional varactor diodes cut off below 15 Gc at −6 v. Capacitance values of the epitaxial varactor units are as low as 0.15 picofarads at − 6 v.

Sylvania says that in tests as L-band doublers, the units show "conversion efficiencies as high as 70 percent." The diodes are available as customer samples this week.

Soviet Academy Cites Advances and Problems

ANNUAL MEETING of the Soviet Academy of Sciences last week stressed progress made by USSR scientists in space and automation. Speakers conceded, however, that one chronic problem still persists: how to translate scientific findings quickly into production-line technology.

A related problem: cooperation between science and industry is unsatisfactory to the Soviet planners. In practice, the annual plan enumerating research achievements recommended for industrial use has mostly included items "of secondary importance." Academicians admit the need for more and better scientific manpower, deplore the "my brother, my enemy" attitude which exists among members of the scientific fraternity.

Among developments cited by speakers at the meeting were: a unit for zone-refining of refractory metals permitting production of single-crystal molybdenum, tantalum and rhenium; progress in control of thermonuclear reactions; weather forecasting by computer techniques using the Strela computer; and an electron-beam micromachining system.

Arms Control Panel States System Needs

ARMS CONTROL experts meeting in a panel discussion in Los Angeles last week stated that if a disarmament agreement were to be reached now, present machinery would not be adequate to put a workable inspection system into operation.

Existing reconnaissance aircraft operating in an "open skies" policy would help; so would project Vela, an explosion-detection program which Pentagon experts describe as a short-range system forced on the U. S. by pressure of past negotiations.

Among present needs: hardware for detecting underground nuclear explosions and explosions occurring in space; a worldwide communications and data-analysis system.

Air Agency Is Conducting Data-Processing Symposium

THREE-DAY research and development symposium will be held this week at Federal Aviation Agency's Atlantic City, N. J., proving grounds to give some 450 FAA people a chance to see how the new data-processing central and semi-automatic air-traffic control system will work. First central goes into the Boston air-route traffic-control center next year.

Besides discussions on the data-processing innovations, FAA will review and demonstrate its whole R&D program—traffic displays, three-dimensional radar, automatic communications, navigation systems, anticollision devices, and so forth.

CASSEGRAIN ANTENNAS: another prime capability of Goodyear Aircraft

1 Transmitting & receiving antennas for U. S. Army Hawk missile

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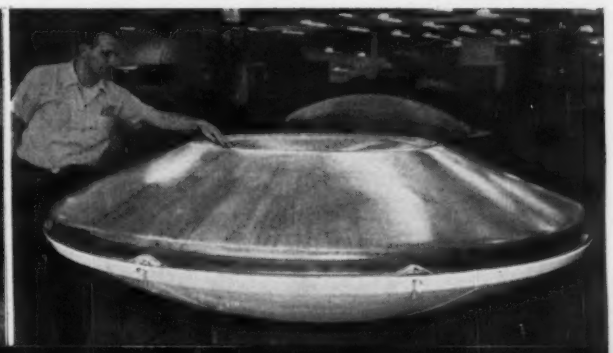
GOODYEAR AIRCRAFT

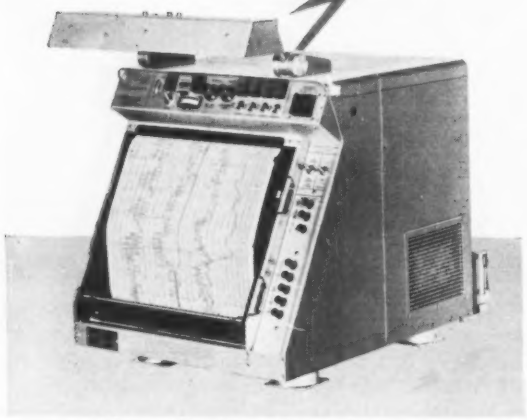
Plants in Akron, Ohio, and Litchfield Park, Arizona | *Providing all 3 weapon system skills* [redacted] MANUFACTURE [redacted]

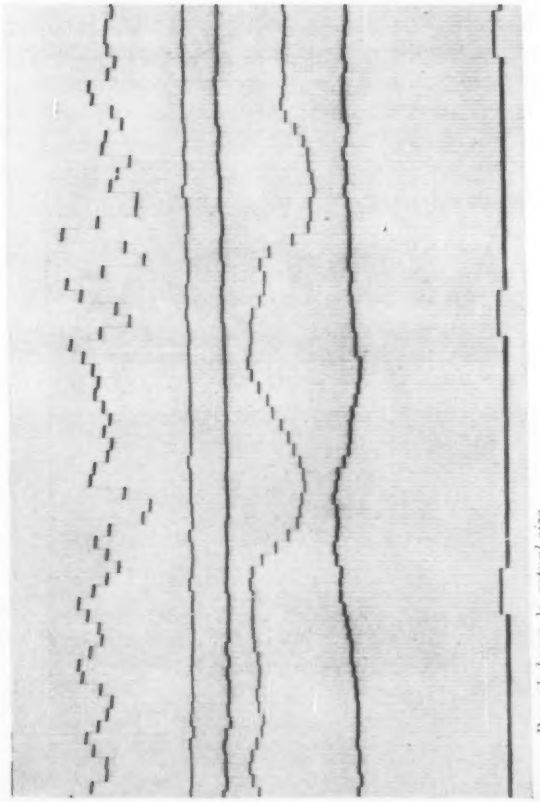
2 Navy missile cruisers employ this large reflector



3 Cassegrain antenna built for U. S. Army Nike-Hercules radar

Tracking a Surveillance Drone with the Visicorder





Record shown ¼ actual size.

Drone surveillance and reconnaissance gives U.S. Army combat units a high-altitude vantage point with much broader horizons from which to view battlefield action and terrain.

If effective use of the data gathered by the drone—the "eye in the sky"—is to be made, accurate instruments have to be on hand to monitor the drone's position and movement, its operational behavior and its response to flight commands. Telemetry supplies the radio link which transmits all this behavior information to a thoroughly-instrumented mobile tactical command post developed by Tele-Dynamics Division of American Bosch Arma Corp.

The Honeywell Model 1012 Visicorder has been selected as the direct readout unit in the Tele-Dynamics Drone Surveillance Telemetry system. In use with its companion instrumentation, the 36-channel Visicorder simultaneously displays the 22 channels of information required to track a drone, plus the timing traces.

In the Tele-Dynamics van, which serves as a tactical command post, the Visicorder provides both an instant "quick look" and a permanent record of the drone's operational parameters.

Signals are transmitted over a single channel by time-multiplexing. Signal and battery strength, engine speed and temperature, pitch and roll commands, altitude, airspeed, attitude (pitch and roll), yaw, acceleration (horizontal and vertical), and angle of attack are recorded by the Visicorder, along with three separate records of vibration.

Like the other units of the Tele-Dynamics system, these Honeywell Visicorders are built for rugged service . . . to deliver the data . . . when the drone is up and the chips are down.

Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration of how a Visicorder Oscillograph will save you time and money in data acquisition. OEM inquiries invited.

Reference Data: write for bulletins 906, 1012, 1108 and 1406.

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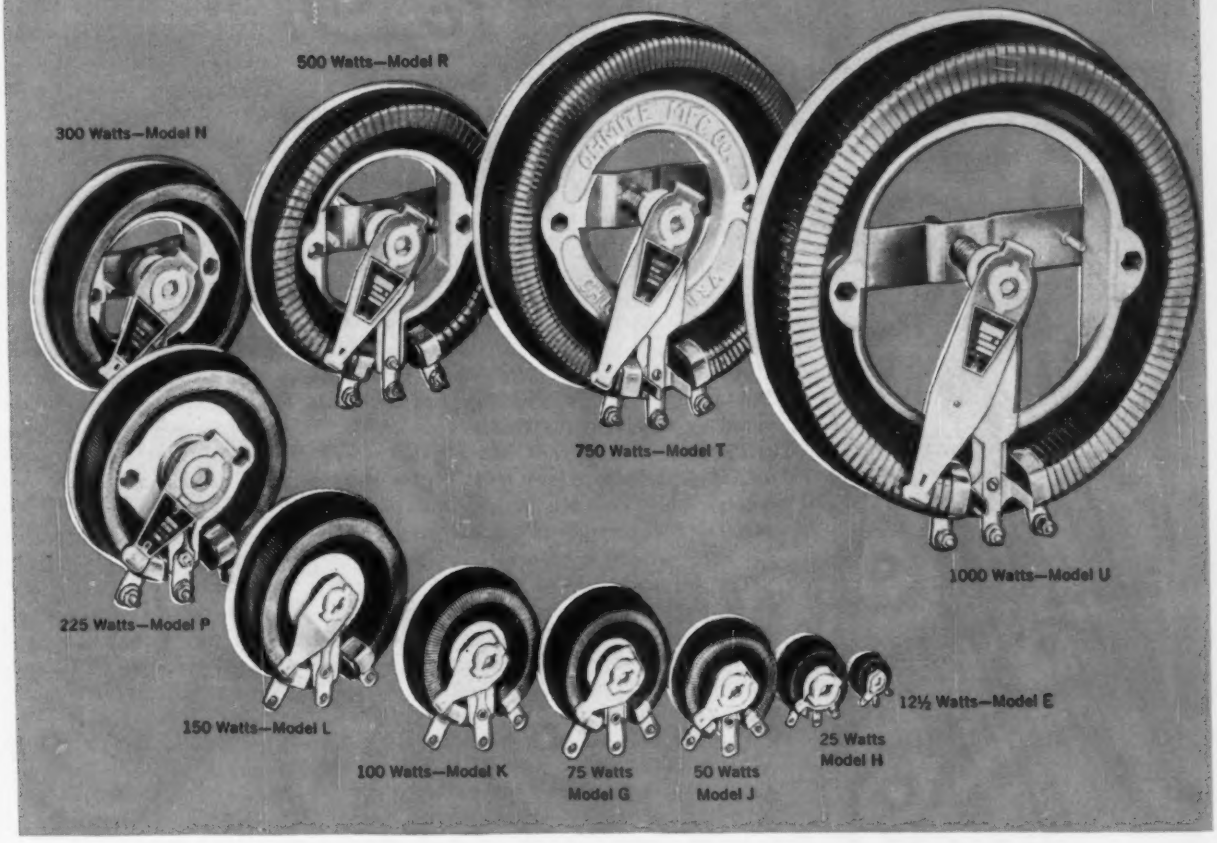

OHMITE offers the largest and most varied assortment of power rheostats ever developed.

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But Ohmite rheostats give you more than just "largest selection." Ohmite wire-wound units of *all ceramic and metal construction* represent the highest degree of operational reliability ever attained in rheostats. They bring you the backup of industry's greatest reservoir of engineering talent in rheostat design and application.

Because of this, you find more Ohmite units in use than all other makes combined. On your next project calling for rheostats, make your selection from the smooth, close control units preferred throughout industry.

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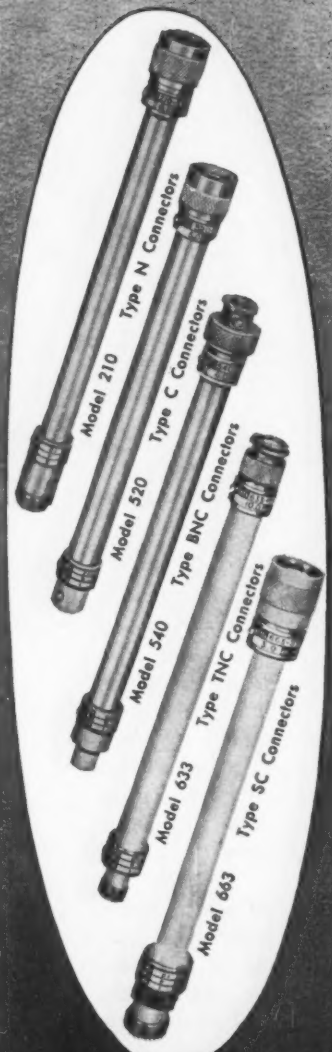
Connectors: Type N, C, BNC, TNC or SC. Each type with male/female, double male or double female connectors. Made with Weinschel Film Resistors for maximum stability.


Model 210 Type N Connectors
Model 520 Type C Connectors
Model 540 Type BNC Connectors
Model 633 Type TNC Connectors
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Write for complete catalog, specifying frequency range of interest.

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WASHINGTON OUTLOOK

THE DEFENSE DEPT., traditionally wary of mixing military contracts with economic pump priming, is now under orders from the White House to review contracting schedules through June. Objective is to determine if the rate of new orders can be speeded up to ease unemployment.

Pentagon officials say contracting can be accelerated somewhat, but are uncertain how much or what projects can be speeded to achieve the President's objective. An Air Force spokesman sees no likelihood for letting contracts on major electronics systems earlier than now planned.

The Kennedy order comes on the heels of a step-up in the Polaris submarine missile and military airlift programs, and a volume of military contracting already running at a higher level than in any year since Korea.

Latest schedules show $22.8-*billion worth of contracts for procurement, research and development, and construction for the current fiscal year. This compares with* $18.9 *billion in fiscal* 1960 *and* $21.2 *billion in fiscal* 1959.

The $22.8-billion figure represents a $1.6-billion increase over the original rate of new orders planned last August for the current fiscal year. Last month, the Eisenhower administration approved the increase. It reflects a revival of contracts held back in the previous year under Pentagon budget restrictions, and authority to use extra defense funds voted by Congress for this year.

These figures do not include the recent step-ups in the Polaris and airlift programs, which will involve close to $700 *million extra in contracts. The Pentagon stresses the distinction between program increases such as Polaris and airlift and accelerated contracting in line with the President's economic objective.*

The services want to develop a faster rate of contracting on a variety of projects. The Army is pumping for more contracts for ground electronic gear and other tactical weapons. The Air Force wants to hurry the award of contracts for design of a new long-range cargo jet plane and the STOL (stationary takeoff and landing) tactical fighter-bomber aircraft.

The Navy is studying possibilities for speeding production of North American Aviation's A3J, McDonnell F4H, Grumman 2F, and Douglas A4D aircraft.

THE IBEW CHICAGO local's warning not to work on imported Japanese electronic components is stirring up an internal labor squabble.

The AFL-CIO policy-making executive council is preparing a major statement reaffirming its free trade position, for release at its Miami meeting later this month. This comes in the face of rising protectionist demands from affiliated unions hit by Japanese imports and unemployment.

Top federation leaders want to stem the rise in protectionist sentiment being voiced, in varying degrees, by several unions in addition to IBEW.

Top-level AFL-CIO strategy against foreign competition is shaping up as a drive to raise labor standards abroad, thus boosting foreign costs and making U. S. goods more competitive in price; efforts to make domestic industries more competitive through the faster introduction of automated production equipment; and federal aid for sagging industries to allow conversion to other types of production.

A NEW AIR FORCE Communications Service will be set up starting this July to take on communications operating responsibilities of major commands and the Airways Air Communications Service. This is in line with the Pentagon's effort to consolidate overall service communications within the new Defense Communications Agency.

Headquarters of the Air Force new command will be Scott AFB, Ill. It will operate and maintain all Air Force point-to-point and air-to-ground telecommunications on a global basis, including operation of terminal and enroute navigational aids.

High selectivity, unique convenience, extreme accuracy

302A Wave Analyzer

easily convertible to a sweep oscillator-tuned voltmeter with this AC-97C Sweep Drive!

No calibration or stabilization is required with the 302A Wave Analyzer, a completely transistorized instrument which represents significant improvement in design. Operating as a highly selective tuned voltmeter, the instrument provides a front panel control which selects the frequency to be measured. Voltage then is read directly on the front panel meter. Basically, Model 302A separates an input signal into individual components so that each—the fundamental, harmonics and any intermodulation products—may be evaluated separately.

With the AC-97C Sweep Drive, the 302A is converted to a sweep oscillator-tuned voltmeter for automatic frequency response measurements, even in noisy systems. The AC-97C motor accessory permits sweeping the entire frequency range of the 302A, 20 cps to 50 KC; provides fast sweep for covering the spectrum rapidly, slow sweep for high resolution plot. The Sweep Drive with an X-Y recorder permits automatic plots of harmonics or intermodulation products. Model AC-97C attaches to the 302A panel, or may be bench mounted on an adjustable stand.

SPECIFICATIONS

302A Wave Analyzer

Frequency Range:	20 cps to 50 KC
Frequency Calibration:	Linear graduation 1 division/10 cps. Accuracy ± (1% + 5 cps)
Voltage Range:	30 μv to 300 v, full scale, 15 ranges
Warm-up Time:	None
Voltage Accuracy:	± 5% of full scale
Residual Modulation Products & Hum Voltage:	Greater than 75 db down
IF Rejection:	Intermediate frequency in input signal rejected by at least 75 db down
Selectivity:	± 3½ cycle b.w. — at least 3 db down ± 25 cycle b.w. — at least 50 db down ± 70 cycle b.w. — at least 80 db down Beyond ± 70 cycle b.w. — at least 80 db down
Input Impedance:	Determined by setting of input attenuator: 100,000 ohms on 4 most sensitive ranges, 1 megohm on other ranges.
Dimensions:	20¾" x 12½" x 14½" (cabinet), 19" x 10½" x 13½" (rack mount)
Weight:	43 lbs. (cabinet), 35 lbs. (rack mount)
Price:	302A (cabinet), $1,800.00 302AR (rack mount), $1,785.00

AC-97C Sweep Drive

Sweep Range:	50 revolutions
Sweep Limits:	Any interval from 50 revolutions to 5 degrees
Sweep Speed with 302A:	170 cps/sec and 17 cps/sec
Mount:	Front panel of 302A or bench stand, adjustable, 4" to 12"
Price:	$275.00

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Flexible SWEEP DELAY

DC-TO-100 MC RANGE

with the Tektronix Type 585 Oscilloscope

Highly adaptable, the Type 585 fits most precision-measurement applications in the dc-to-100 mc range —when used with a Type 80 Plug-In Unit and P80 Probe. The three-way combination features:

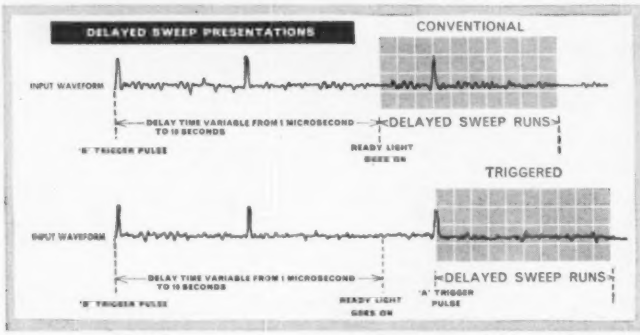
1... slow sweeps as well as fast sweeps and *versatile main sweep triggering facilities compatible with the bandwidth capabilities*— for general-purpose laboratory work;

2... 3.5 nsec risetime, 0.1 v/cm sensitivity, 10 nsec/cm sweeptime— for high-speed pulse analysis;

3... two modes of calibrated sweep delay: either Conventional (when the delayed sweep is started at the end of the delay period by the delayed trigger) or Triggered (when the delayed sweep is started after the delay period by the signal under observation)— for a wide variety of specialized applications.

For example, the delayed-sweep enables you to observe the start of the horizontal sweep from 1 microsecond to 10 seconds after receipt of a triggering signal . . . to make precise incremental measurements along a complex waveform . . . to obtain high magnification of a selected portion of an undelayed sweep—with jitter-free magnification up to 10,000 times.

Further, the exact portion of the display on the delaying sweep that will appear on the faster main sweep is positively identified by trace brightening, and the Single-Sweep feature facilitates photographic recording of most one-shot phenomena.



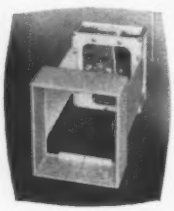
TYPICAL DELAYED SWEEP APPLICATIONS

- Display separate channels of a PTM system, with effects of time jitter removed, determining pulse amplitude and shape under conditions of modulation.
- Measure pulse-to-pulse intervals and amount of jitter on computer signals or any train of pulses.
- Determine accurate time-difference measurements between pulse-in and pulse-out through an amplifying system.
- Select any individual line of a television composite signal.
- Show time displacement, wave shape, and amplitude of individual channels in a telemetering system.

TEKTRONIX PLUG-IN FEATURE

further enhances the versatility of the oscilloscope

Designed for interchangeable preamplifiers, the Type 585 will also accept the present 16 "letter-series" plug-in units without loss of bandwidth or basic sensitivity of the plug-in —*when used with the Type 81 Adapter.*



TYPE 585, without plug-in unit	**$1675**
Type 80 Plug-In Preamplifier	**50**
P80 Probe	**100**
Type 81 Plug-In Adapter	**125**

Prices f.o.b. factory

Note: Both the Type 80 Plug-In Preamplifier and P80 Probe are necessary for dc-to-100 mc operation. The Adapter allows insertion of Tektronix "letter-series" plug-in units.

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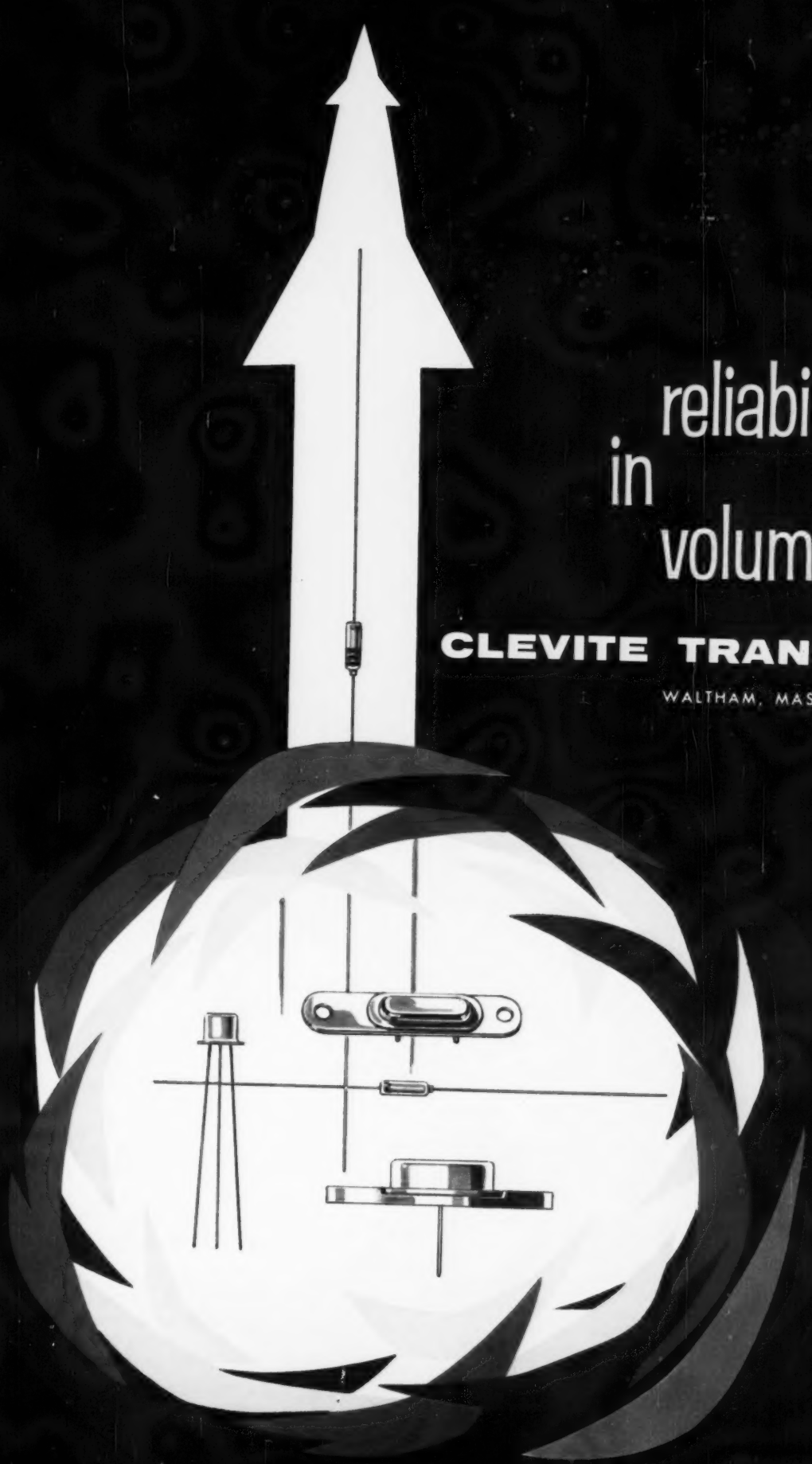

reliability
in
volume...

CLEVITE TRANSISTOR

WALTHAM, MASSACHUSETTS

How to establish rating values for power transistors

by RICHARD F. MOREY, JR.

Manager, Applications Engineering, Clevite Transistor

Division of Clevite Corporation

Every manufacturer of power transistors provides information on the various circuit valves within which a given transistor will satisfactorily perform. These valves or "ratings" are established on the absolute maximum system and are defined so that "the rating values, if exceeded, will cause permanent impairment of the device." Since permanent damage can occur as a result of exceeding rating limits or as a result of an unqualified rating, Clevite Transistor exercises great care in the development of ratings and the proof of their validity.

Clevite places particular emphasis on ratings for junction temperature, power dissipation, collector current, and collector voltage. Each of these ratings is independent and it is not generally possible to approach more than one rating simultaneously. Therefore, specific tests are performed such as "thermal resistance" to establish maximum power dissipation and collector diode leakage current 1_{CBO} at both room temperature and high operating temperature to establish maximum rated collector to base voltage. Figure 1 is a diagram of the Thermal resistance test, while Figure 2 indicates the testing configuration for establishing essential collector to emitter voltage ratings.

Other tests are performed to determine collector current and junction temperature. High-temperature-storage life tests to establish maximum junction temperature are further supplemented by Clevite's process of aging transistors at temperatures in excess of the eventual maximum rating.

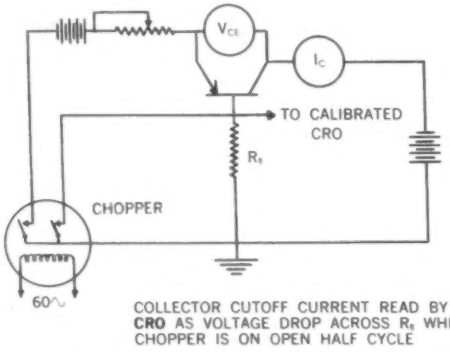

Fig. 1. Thermal resistance test

Perhaps the most important tests are the collector to emitter breakdown tests ($V_{CES\ (sus)}$ and $V_{CEO\ (sus)}$) which are used to determine the maximum collector to emitter voltage. Figure 3 indicates a typical germanium power transistor operating in breakdown region. Observe that the bias applied between emitter and base differs for each of the seven curves. This bias differential causes the curves to differ significantly. Curve 1 breaks down sharply at 45 volts, while curve 6 breaks down initially at 118 volts, but upon transversing the curve, the voltage drops and another breakdown occurs at a point slightly greater than 60 volts. Curves 2, 3, 4, and 5 are somewhere between.

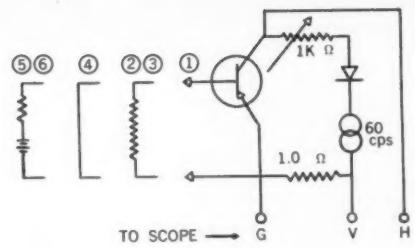

Fig. 2. Collector to emitter voltage test

Curve 7 is simply the curve of the collector to base diode and is shown here for reference purposes.

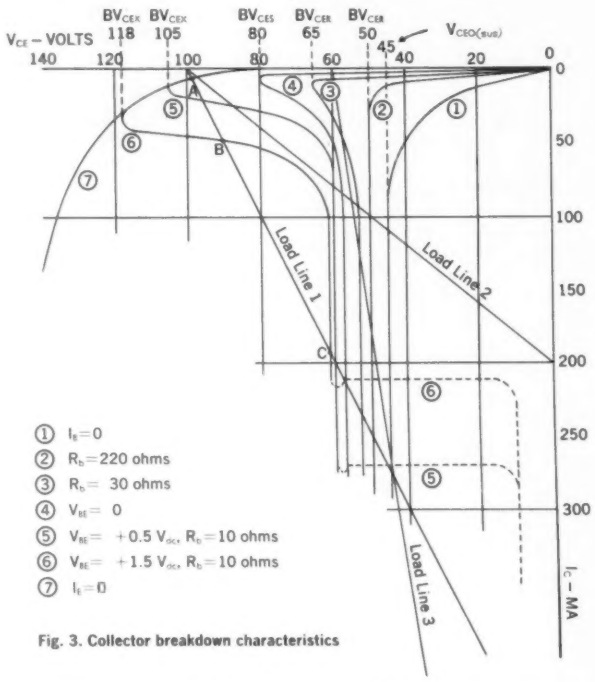

Fig. 3. Collector breakdown characteristics

It may be noted in a particular instance, such as curve 1, that at some voltage (in this case 45 volts) collector current increases without limit. This is the voltage at which collector multiplication causes the overall current gain (alpha) to equal unity.

The remaining curves serve to indicate the effect of a change in bias at different voltage and current conditions.

The tests and data shown here are only a segment of the total program undertaken by Clevite Transistor to assure a continuous high standard of product quality . . . "reliability in volume."

Detailed Technical Data Bulletins are available on all Clevite's Power Transistors and Diodes. To obtain technical information, please request Application Bulletins 1 & 2.

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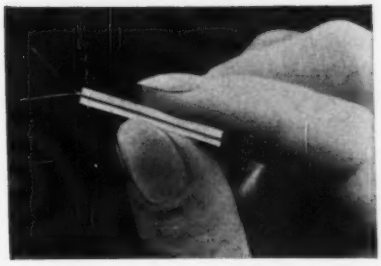

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CIRCLE 19 ON READER SERVICE CARD→

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SIZE DESIGNATION	PLUG O.D.	NO. OF COAXIAL CONTACTS	NO. OF POWER CONTACTS
A	¾"	up to 7	up to 19
B	1⅜"	up to 12	up to 37
C	1⅞"	up to 19	up to 61

Microdot Multi-Pins are available in disassembled "kit" form or, if you prefer, factory assembled with Microdot cable.

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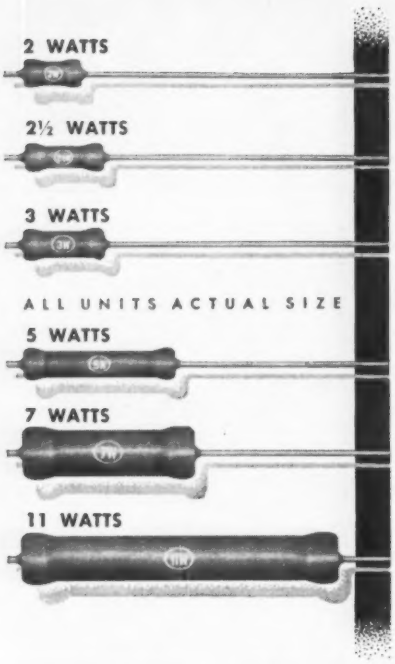

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GROSS 1960 INCOME for International Business Machines Co. was $1,436,053,085 in the U. S., an increase of $126,265,048 over the previous year. Net earnings after federal taxes were $168,180,880, a $22,547,668 increase over 1959. Earnings per share in 1960 were $9.18 based on the 18,310,954 shares outstanding at the end of the year. Earnings in 1959 were $7.97 per share on the 18,268,943 shares outstanding.

Company spokesmen say total assets at the end of 1960 amounted to $1,535,365,919. During 1960 the company's increased volume of business and replacement of obsolete equipment required an investment of $339,995,042 in rental machines and parts, factory and office equipment, land and buildings.

IBM World Trade Corporation, a wholly owned subsidiary, reported gross income of $372,273,076 in 1960, an increase of $75,374,575 over 1959. Net income was $48,809,514, a rise of $8,607,411 over 1959.

RAYTHEON CORP. reports earnings in 1960 were $8,105,000 after taxes. This is equal, after preferred dividends, to $2.09 per share of common stock on 3,728,247 shares outstanding at the end of 1960. Earnings from operations in 1959 were $10,481,000, equal to $3.01 per share on 3,423,567 common shares then outstanding.

Company officials reported two special items for last year. The first was an after-tax gain of $5,040,000 (or $1.35 per share) received in connection with European production of the Hawk missile system. The second item was a special charge of $1,609,000 (after related tax credit) amounting to 43 cents a share, as a result of price reductions on components used in certain government contracts from 1956 through 1959.

With special items added, the company's total profit for 1960 comes to $11,536,000 after provision for taxes.

WESTINGHOUSE ELECTRIC reports 1960 net income about equalled 1959's. The 1960 figure was $79,057,000, or $2.22 per common share. In 1959, net income of $85,947,000 or $2.43 a common share, included $7,196,000 (21 cents a share) of special nonrecurring income from a federal tax refund.

Net sales in 1960 were $1,955,731,000, compared with $1,910,730,000 in 1959. Provision for federal and foreign tax in 1960 was $65,900,000, against $73,600,000 a year earlier.

BECKMAN INSTRUMENTS, Anaheim, Calif., reports a 24-percent increase in sales and a 26-percent increase in operating earnings for the six months ended Dec. 31, 1960. A. O. Beckman, company president, said both figures set new records. Sales for the period were $31,423,505, as against $25,442,965 for the corresponding portion of 1959. Net earnings amounted to $1,586,010, equal to $1.15 per share, as against $1,262,172 or 93 cents a share in the last half of 1959.

TECHNICAL MATERIEL CORP., Mamaroneck, N. Y., manufacturer of communications equipment, reports new records set for 1960. Sales last year were $6,648,925, as compared with a figure of $5,028,453 in 1959. Earnings before taxes were $997,333 last year, as against $645,233 in 1959. Earnings per share for the two years were 90 cents in 1960, 59 cents in 1959.

DAYSTROM INC., Murray Hill, N. J., for the nine months ended Dec. 31 last year, recorded a net profit of $1,121,000 after taxes. This is equivalent to 89 cents a share on 1,255,307 shares outstanding. For the corresponding period of 1959, net earnings of $1,405,000 were made, equal to $1.12 a share on the same number of shares, or $1.54 a share on the 915,073 shares actually outstanding at that time. Sales for the last nine months of 1960 were $68,756,000, as compared with

$65,524,000 in the same period of 1959. Provision for federal income taxes last year was $990,000, as compared with $1,449,000 in 1959. T. R. Jones, Daystrom chairman, said that although the company was experiencing the cost and price pressures of today's financial conditions, the greatest impact on earnings stemmed from enlarged research and development expenditures.

CROSBY-TELETRONICS, New York City, reports sales and earnings at record highs for fiscal 1960. Sales reached $1,683,010, representing more than $1 million increase over the previous year's $463,179.

The firm had a net profit of $35,263 during the fiscal year just ended, as against a net loss during the previous fiscal year of $213,858. Earnings per share amounted to five cents.

GARRETT CORP., Los Angeles, in a preliminary report for the first six months of its fiscal year which ended Dec. 31, 1960, announces sales of $94,506,000 and a net profit of $711,000, or 67 cents a share on the 1,064,971 shares outstanding at the beginning of the period. For previous quarter the per-share figure was 31 cents.

25 MOST ACTIVE STOCKS

WEEK ENDING FEBRUARY 3, 1961

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Gen Tel & Elec	3,336	30	26⅞	29⅛
Lockheed	2,921	32⅜	27¼	31⅜
Gen Elec	2,750	71½	67⅛	69⅞
Sperry Rand	2,368	23½	22⅜	23⅛
Avco	2,338	15⅞	14⅝	15¼
Westinghouse Elec	1,681	48¼	44⅝	47½
Ampex	1,652	22⅜	20½	21¾
Gen Dynamics	1,360	45½	40⅛	44⅜
Burroughs Corp	1,286	33⅛	29⅛	32⅝
Universal Controls	1,031	14¾	13¾	14
Siegler Corp	868	31⅞	27¾	31⅞
RCA	831	57¼	55½	56½
Int'l Tel & Tel	724	48⅝	47⅜	48
Hycon Mfg	622	4	3⅝	3¾
Collins Radio	610	46⅜	42¼	45⅜
Martin Co	595	65	58¾	59¼
Transitron	588	34⅞	32½	34¼
Lear Inc	574	19	17¼	18
American Elec	532	10¼	8⅝	10¼
Ling-Temco	517	28½	26⅜	27¼
Standard Kollsman	469	28½	26⅜	26⅝
Raytheon	467	38½	36⅜	38
Elec & Mus Ind	448	6	5¾	5⅞
Republic Aviation	439	33⅜	30¾	33
Am Bosch Arma Cp	431	18⅞	16¾	18⅝

The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co., investment bankers.

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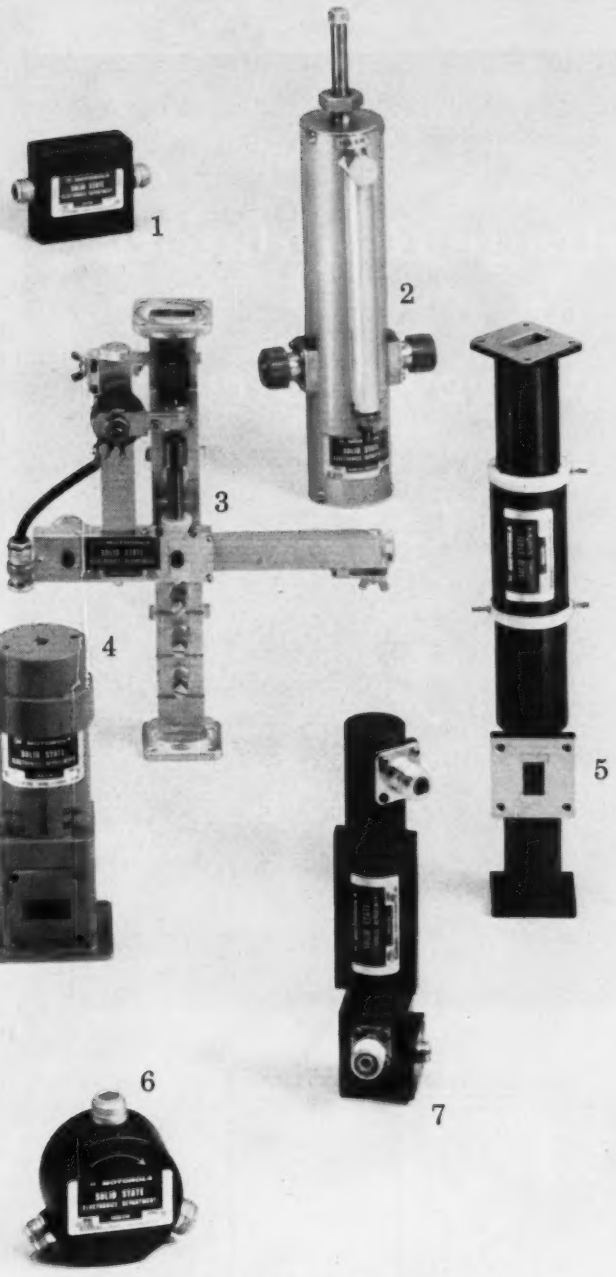

DR. ARTHUR L. ADEN, PH.D. (Applied Physics); Manager, Solid State Electronics Dept.; applied physics, electrodynamics, solid state devices R&D, and microwave applications of magnetic ferrites.

JOHN C. CACHERIS, M.S.E.E.; Manager, Solid State Devices Laboratory; solid state devices R&D; awardee of several patents for microwave ferrite applications, and author of numerous technical publications.

NICHOLAS G. SAKIOTIS, B.E.E.; Section Head (microwave ferrite devices), Solid State Devices Laboratory; winner of several important awards, including the PGMTT Annual Award for Outstanding Contributor to the Microwave Art, 1956, and the Scientific Research Society of America "Applied Science Award", 1959.

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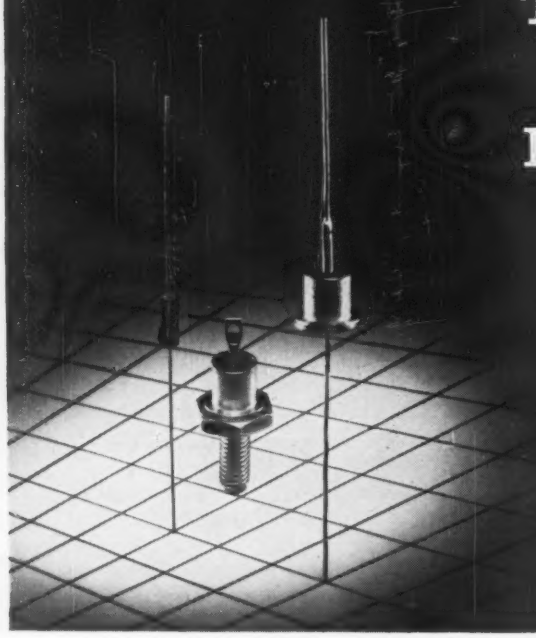

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.25T6.2	6.2	25	4.1	1N709
.25T6.8	6.8	25	4.7	1N710
.25T7.5	7.5	25	5.3	1N711
.25T8.2	8.2	25	6.0	1N712
.25T9.1	9.1	12	7.0	1N713
.25T10	10	12	8.0	1N714
.25T11	11	12	9.0	1N715
.25T12	12	12	10	1N716
.25T13	13	12	11	1N717
.25T15	15	12	13	1N718
.25T16	16	12	15	1N719
.25T18	18	12	17	1N720
.25T20	20	4	20	1N721
.25T22	22	4	24	1N722
.25T24	24	4	28	1N723
.25T27	27	4	35	1N724
.25T30	30	4	42	1N725
.25T33	33	4	50	1N726
.25T36	36	4	60	1N727
.25T39	39	4	70	1N728
.25T43	43	4	84	1N729
.25T47	47	4	98	1N730
.25T51	51	4	115	1N731
.25T56	56	4	140	1N732
.25T62	62	2	170	1N733
.25T68	68	2	200	1N734
.25T75	75	2	240	1N735
.25T82	82	2	280	1N736
.25T91	91	1	340	1N737
.25T100	100	1	400	1N738

1 Watt Voltage Regulators
Specifications 25°C.

Tarzian Type	Zener Volt. (V)	Test Cur. (Ma)	Dyn. Imp. (Ohms)
1T5.6	5.6	100	1.2
1T6.2	6.2	100	1.5
1T6.8	6.8	100	1.7
1T7.5	7.5	100	2.1
1T8.2	8.2	100	2.4
1T9.1	9.1	50	3.0
1T10	10	50	3.5
1T11	11	50	4.2
1T12	12	50	5.0
1T13	13	50	5.8
1T15	15	50	7.6
1T16	16	50	8.6
1T18	18	50	11
1T20	20	15	13
1T22	22	15	16
1T24	24	15	18
1T27	27	15	23
1T30	30	15	28
1T33	33	15	33
1T36	36	15	39
1T39	39	15	45
1T43	43	15	54
1T47	47	15	64
1T51	51	15	74
1T56	56	15	88
1T62	62	5	105
1T68	68	5	125
1T75	75	5	150
1T82	82	5	175
1T91	91	5	220
1T100	100	5	260

10 Watt Voltage Regulators
Specifications 25°C.

Tarzian Type	Zener Volt. (V)	Test Cur. (Ma)	Dyn. Imp. (Ohms)	Indec Type
10T5.6	5.6	1000	1	1N1803
10T6.2	6.2	1000	1	1N1804
10T6.8	6.8	1000	1	1N1805
10T7.5	7.5	1000	1	1N1806
10T8.2	8.2	1000	1	1N1807
10T9.1	9.1	500	1	1N1808
10T10	10	500	2	1N1351
10T11	11	500	2	1N1352
10T12	12	500	2	1N1353
10T13	13	500	2	1N1354
10T15	15	500	2	1N1355
10T16	16	500	3	1N1356
10T18	18	150	3	1N1357
10T20	20	150	3	1N1358
10T22	22	150	3	1N1359
10T24	24	150	3	1N1360
10T27	27	150	3	1N1361
10T30	30	150	4	1N1362
10T33	33	150	4	1N1363
10T36	36	150	5	1N1364
10T39	39	150	5	1N1365
10T43	43	150	6	1N1366
10T47	47	150	7	1N1367
10T51	51	150	8	1N1368
10T56	56	150	9	1N1369
10T62	62	50	12	1N1370
10T68	68	50	14	1N1371
10T75	75	50	20	1N1372
10T82	82	50	22	1N1373
10T91	91	50	35	1N1374
10T100	100	50	40	1N1375

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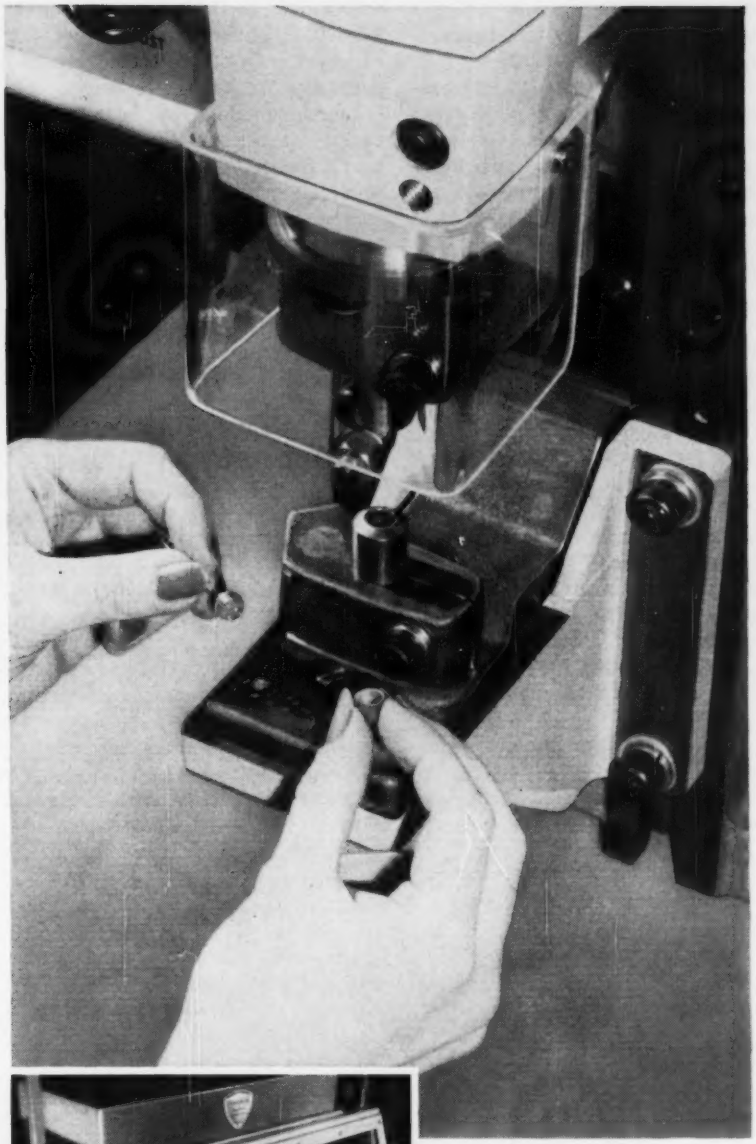

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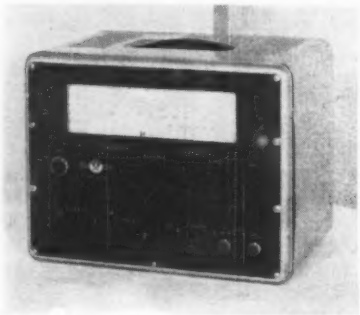
ELECTRONICS IN HUNGARY

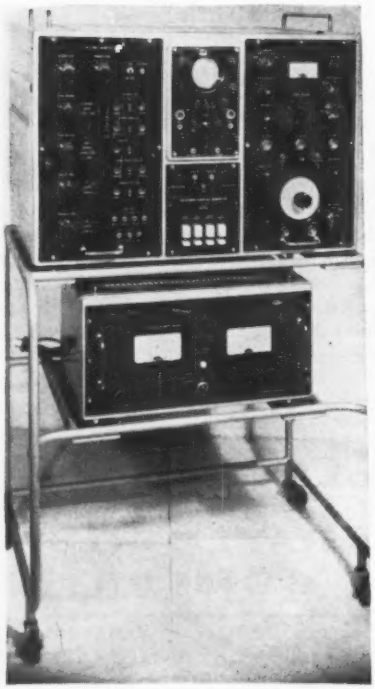
By F. H. BAER McGraw-Hill World News

VIENNA, AUSTRIA—A country not blessed with riches of raw material and energy resources, Hungary is forced to turn major attention to produce industrial goods of high labor intensity, with electronics and instrument-building industries forming two major pillars of entirely nationalized economy.

At that, Hungary has some tradition: the country's oldest radio factory—Orion—is more than 40 years old, the Tungsram plant (before nationalization a branch of international concern) is equally old, and Beloiannis plant (now BHG) is 25-year-old producer of telecommunication equipment.



Television sweep generator



Complex, 12-channel generator for tv

There are more than 30,000 people employed in these production branches, working in about a dozen bigger plants, and in an undisclosed number of multishop cooperatives. The latter are obviously former small workshops.

Today, the instruments factory lists about 3,700 basic models with more than 40,000 offspring from basic equipment. Industry output satisfies not only domestic needs (save for few specialized models) but allows exports of some 50 percent of production. Naturally, almost 80 percent of exports are routed to fellow East-European countries, remainder to Western countries. Nearly 65 percent of country's radio receivers are Orion models, and nearly 100 percent of television sets.

Incomplete information received in Budapest lists these major enterprises:

"EMG," an Orion division (Budapest), is Central Europe's largest electronics producer, employing 1,500 (1961 goal: 2,000), turning out primarily electronic measurement instruments.

"EKM" (Budapest), telecommunication indication and measuring instruments, employs some 1,500 workers, nearly a third of them engineers and technicians.

"BOM" (Budapest), medical instruments on electronic basis; "EMG"—Nuclear Department (Budapest), nuclear instruments; "GAMMA" (Budapest), nuclear instruments, optical instruments; "FMV" (Budapest), precision engineering for micro-wave measurements.

"BHG" (Budapest), telecommunication equipment; "MMG" (Budapest), automation elements: electronic-pneumatic and pneumatic; "Orion" (headquartered in Budapest), radio, television, tape recorders; "Tungsram" (Budapest), vacuum tubes, capacitors, resistors, potentiometers, transistors and, in addition, germanium diodes.

Among cooperatives, two were mentioned to ELECTRONICS: first "Orion", which actually consists of eight industrial plants plus cooperative workshops producing as economic unities, but bearing the factory name for product identification. Secondly, the "GYEM", a co-op of small workshops for production and repair of light-current instruments, among them units for electronic testing of metals.

Domestic trade is handled through MIGERT, a state distribution agency which distributes—according to advance plans—products from all plants to domestic consumers, regardless whether investment or consumer products are concerned.

Foreign trade is handled mainly by two agencies, METRIMPEX and ELEKTROIMPEX, the first for instruments, the latter for components and electronic consumer goods.

Orders reaching Hungary from fellow East European countries come within the long-range (5-year) goods exchange plans existing on bilateral basis. Leeway can take place only within given monetary amounts, e.g. concerning models, types and versions but not altering agreed values. Orders from the West are accepted without any previous planning as each plant reserves a certain (variable) part of capacity for just such orders.

Dominating producer of tubes, diodes, transistors and photocells is Tungsram, one of few Hungarian state enterprises entitled to do direct export business without passing through state's foreign trade agencies.

Orion is factory's name dominating consumer products supply. Firm was established 40 years ago, but now shares name with half dozen new enterprises turning out radios, television sets, tape recorders, large indoor and outdoor acoustics equipment and electronic scoreboards.

Official statistics reports indicate 1959 export of 78,883 radio sets and 42,575 tv sets out of produc-

tion of 258,998 radios and 88,124 television sets. Output of radios dropped sharply but production of televisions increased. Radio exports were directed toward Belgium, Netherlands, Scandinavian countries, North African countries, Portugal and Latin American countries.

Tv exports went mainly to Netherland and Iraq, in addition, of course to other East European countries. Tape recorded production increased from 8,396 sets in 1958 to 17,026 in 1959.

Radio set production includes 20 standard sets. The price list for 1960/1961 shows 17 stationary and 3 portable sets. Each of the latter is fitted with 7 transistors and 2 germanium diodes, while only two of the stationary radio have germanium diodes in addition to vacuum tubes. One new stationary model is also fitted with 7 transistors in addition to two diodes.

Five scientific research institutes and a large (undisclosed) number of factory laboratories cooperate among themselves, but have no centralized supervisory agency. Serving as catalyst is "Electronics Society" one of the 25 specialized societies united in the "House of Hungarian Technics."

The five national research institutes, organized within Hungary's Academy of Sciences, are these: Research Institute for the Measurements Instrument Industry, Research Institute for the Textile Industry, Research Institute for Telecommunication (Microwave), Central Research Laboratory for Measurement Technics, Central Physics Research Institute (Nuclear Instruments).

An exception to the purely scientific pattern of institutes is Textile Research Institutes which not only develops but also manufactures small numbers of special instruments for local distribution.

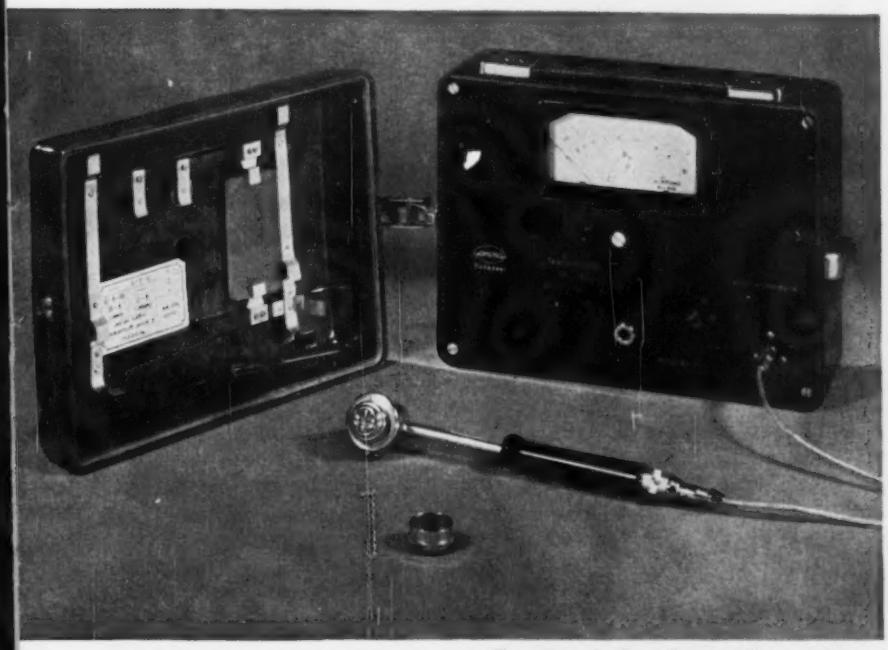
Novel instruments include a titrometer for chemical analysis. It operates at 1,000 mc. It is made up of a rectifier, a voltage stabilizer, a high-frequency oscillator circuit and a compensating circuit.

Another novelty is a local battery telephone set which features a direct in-series connection from magneto to the bell, a design which causes high-pitch ringing in case of a shortcircuited line.

R&D also shows in high accuracy of measuring instruments: a high-precision signal generator with an operating range extending from 10 kc to 50 mc has a margin of error of ±0.5 percent. Very high accuracy is also noted for a spectrum generator which turns out, through its quartz crystal, decadic frequency from 100 cps up to 10 mc.

R&D work in television resulted recently in a novel f-m-demodulation system called "synchronous detection". Three engineers developed a new valve model with demodulator unit. This distortion-free detector is attached in novel circuit in a single unit with a limited and an audio-frequency amplifier.

Novel lab equipment includes semitransistorized pH measuring sets. A 24-channel seismic set, serving for exploration purposes, is portable, needs but four men to carry it anywhere.



Transistorized surface testing equipment

Magnetic Bottle Machine Causes Stir In Sweden

STOCKHOLM—News of attainment of a 40-million-degree temperature for 10^{-3} sec using magnetic bottle or mirror machine by Richard E. Post of Lawrence Radiation Laboratory in Livermore, Calif., has been received with great interest in Swedish scientific circles.

Interviewed by ELECTRONICS Editor W. W. MacDonald here, Dr. B. O. Lehnert of Royal Institute of Technology said he and others have long believed thermonuclear reactions in plasmas could be further observed using such bottles if multistage machines were used to reduce blanking by neutrons and other side effects.

Dr. Lehnert further stated that duration of high temperature achieved at Livermore is of particular significance since it exceeds by about 10 times the theoretical rate of common instabilities and therefore tends to prove the magnetic bottle approach does not have the limitations that have sometimes been assumed in early theory.

At the Royal Institute work is now trending toward development of rotating plasma machines, in one experiment simulating the action of gasses upon energy generated within earth's magnetic field and in another the action radiation from the sun entering earth's field—as aurora phenomenon.

In both types of plasma machines under development action is consistent with phenomena observed in studies of the Van Allen Belt.

Production-Line Diodes Being Irradiated

By THOMAS MAGUIRE
New England Editor

BOSTON — Production-line irradiation of silicon diodes for high-speed switching applications is spreading in the semiconductor industry (see ELECTRONICS, p 11, Sept. 30, 1960).

Meanwhile, research divisions of semiconductor firms are pursuing basic research programs to find out what other effects flow from bombardment of the crystal's lattice structure.

At Burlington, Mass., High Voltage Engineering Corp. time-rents its radiation facility to semiconductor firms for bombardment of devices with monoenergetic beta radiation from a 1.5-mev Van de Graaff electron accelerator on a conveyor line.

High Voltage declines to discuss customers' data, but one semiconductor firm is using the facility to irradiate its entire line of switching diodes for data processing applications. Other firms have installed in-plant irradiation equipment.

One approach is to fabricate a switching diode by conventional methods but without regard for switching properties. The completed device is then irradiated, and one firm's measurements show the 10 microsecond switching time of the untreated diode was cut to 10 millimicroseconds.

Says the research director of a specialized semiconductor firm: "We are bombarding complicated switching devices now, to determine the effects of ionizing radiation.

"Tests on diodes," he continues, "show that the forward conductance is hurt a little, but for switching applications—who cares?"

The process substitutes for chemical doping to control lifetime, but does not supplant chemical doping for production of *n* or *p* types.

Irradiation is reported to be completely effective for silicon but not germanium, at least not when the germanium device is exposed to wide temperature ranges.

Researchers report that the radiation effect will anneal out of Ge at 200 C in a matter of days. With Si, however, annealing effect at 200 C is reportedly negligible and the radiation "damage" is stabilized.

Another approach being tried is recovery of diodes which had to be derated because of failure to pass switching-frequency tests. Irradiation of the device after fabrication is completed may provide a convenient way of increasing production yield.

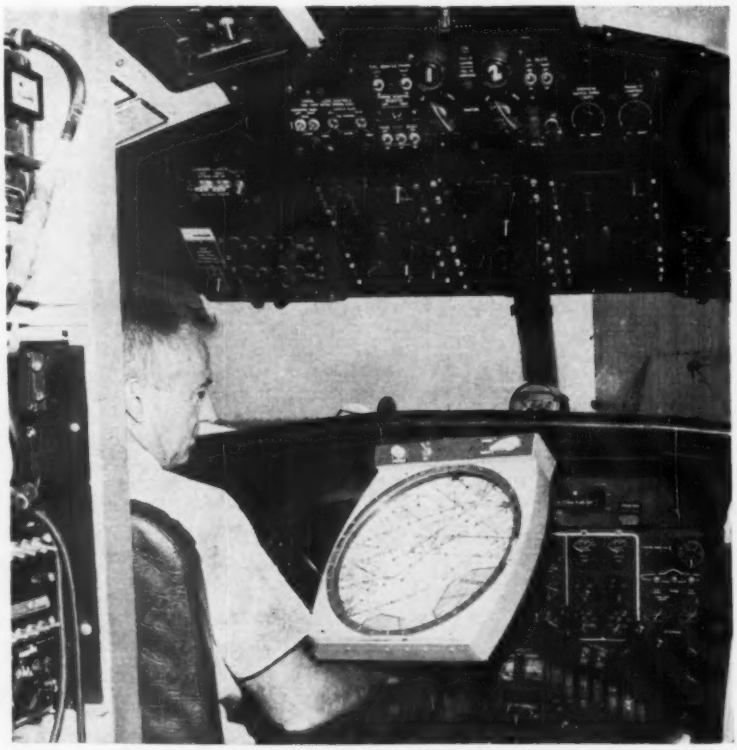
Basically, the radiation decreases lifetime of minority carriers, and the only advantage seen so far is in switching speed. Bombardment increases the upper frequency limit by shortening the lifetime of the carriers.

The duration of reverse transient currents is reduced by creating lattice displacements within the semiconducting material.

Semiconductor firms are also experimenting with irradiation of transistors. Irradiation lowers gain, and this obviates its desirability in most cases. There are some applications, however, where a user would be willing to trade off some gain for a faster switching speed; and in these cases, irradiation would be useful.

The amount of exposure for a given semiconductor diode type and a given energy level is determined by test exposure methods followed by measurement of the reverse transient current. If first exposure period does not produce sufficient reduction, the diode may be subjected to further exposure. However, overexposure can permanently damage the diode.

New Vortac Pictorial Display



Compact unit, developed by ITT, gives a continuous fix on map. Maps are changed en route, each centered around a Vortac station. Fix shows as intersection of radial line (bearing) and spiral line (distance)

Solid-State Show Stressing Tunneling and Microwave

AS THIS WEEK'S Solid-state Circuits Conference at the University of Pennsylvania drew to a close, experts were saying the tunnel diode has now proved itself a working component, rather than a laboratory oddity.

The three-day conference featured papers on microwave and computer application of tunnel devices and techniques. Along with these, microelectronics, magnetic film, and optical maser advances were major themes.

An invited paper by E. Baldinger of University of Basel, Switzerland, detailed equivalent circuit representation of the tunnel diode, I. Giaever of General Electric presented information on superconducting tunneling devices; C. Kim and J. Hopkins of GE gave data on high power operation at high frequencies (higher than self-resonance) of tunnel diodes. From the other papers read, indications are that progress in the microwave application of tunnel diodes will permit future design of solid state equipment with better efficiency.

Computer logic, switching and storage; using thin films, hydraulic logic components, superconducting, and tunneling techniques stirred interest. High speed computer technology was advanced considerably.

At an informal discussion, microelectronic methods were probed in an effort to place pros and cons in perspective, with "blue sky" concepts thrashed out by leaders in the field.

E. Goto of University of Tokyo, Japan, in an invited paper, reported on parametrons in computers built in that country, comparing them with the tunnel diode.

Planar double-diffused transistors were explored as components in a d-c differential amplifier comparable in performance to chopper stabilized designs, in a paper by D. Hilbiber of Fairchild Semiconductor Corp.

Multicontact Hall plates were described in a paper by G. Arlt of Philips, Holland, detailing power output and efficiency increases. H. D. Crane, Stanford Research Institute, described a novel logic technique in his paper on the neuristor.

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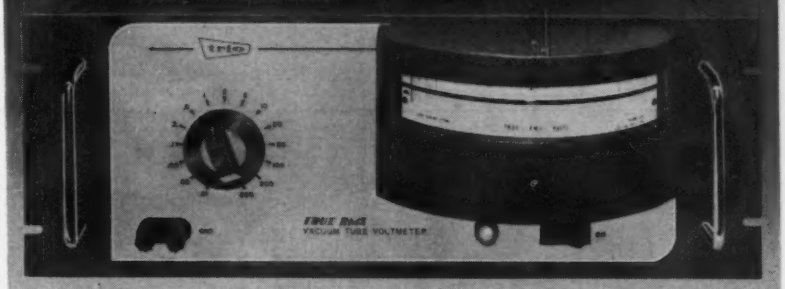

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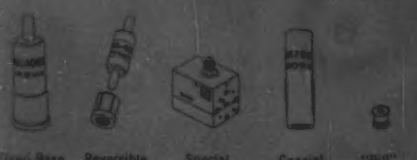

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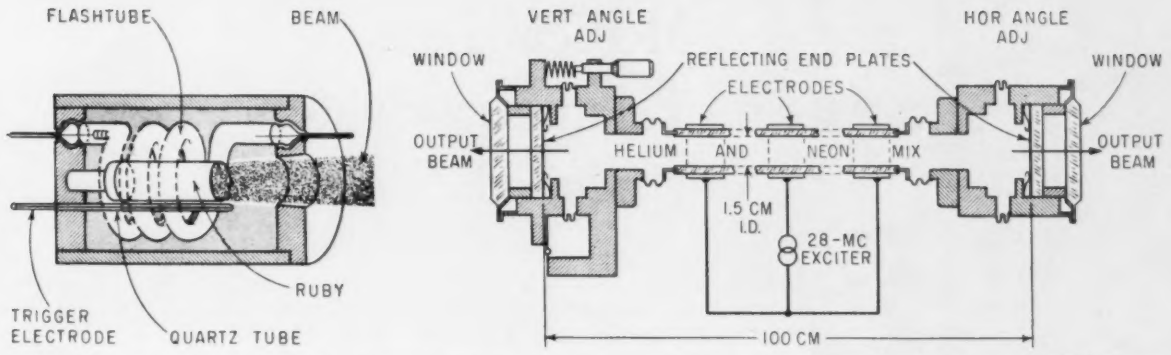


Optical masers such as the Hughes Aircraft ruby maser (left) and Bell Labs' gaseous-discharge maser (right) may eventually find applications in space communications and in basic scientific research

Gases and Solids Studied as Optical Masers

By MICHAEL F. WOLFF
NILO LINDGREN
Assistant Editors

WORK on optical masers is moving towards both solid-state and gaseous-discharge types. Work on both types was reported on recently at the American Physical Society Annual Meeting in New York City.

Bell Labs' gaseous-discharge continuous-wave maser (ELECTRONICS, p 11, Feb. 10) was described in a post-deadline paper at the meeting. This gas maser has been operated for a few hundred hours. It provides a coherent output in the near infrared region.

Also reported was further work on the solid-state ruby maser (ELECTRONICS, p 43, July 22, 1960). Although continuous-wave operation has not yet been obtained with ruby masers, researchers are confident that c-w will eventually be achieved, though cryogenic cooling probably will be required.

A satellite-line maser, which provides maser emission at two separate wavelengths, was reported by Bell Labs. The satellite-line maser requires addition of larger concentrations of chromium in ruby. The Hughes pink ruby maser, which contains only small amounts of chromium, gives optical maser action at 6,934 angstroms (the so-called R_1 line). With a ten-times higher concentration of chromium, emission occurs at 7,009 and 7,041 angstroms, either separately or simultaneously. Although it was originally thought that satellite-line emission could be achieved with low power inputs, this has not yet been demonstrated.

One of the major difficulties with solid-state masers is the irregularities in the crystal structure, a problem not present with gaseous-discharge types.

Present feeling is that solid-state masers will be capable of higher power output than gaseous-discharge masers, but the latter have much narrower linewidth (Bell reports a linewidth between 10 and 80 Kc) and do not require cryogenic cooling to obtain c-w operation. Ultimately, it is expected that both types may complement each other as gases capable of higher output powers and more monochromatic solids are developed.

Technical Research Group is working on a gas-discharge (mercury and krypton) system, a rare earth system, as well as ruby masers, both satellite and R_1-line types. IBM recently announced a doped-calcium-fluoride system (ELECTRONICS, p 11, Dec. 23, 1960).

Some details of the BTL gas maser are shown. This maser uses an 80-cm quartz tube containing a mixture of helium and neon at pressures of 1 and 0.1 mm of mercury, respectively. The tube is terminated at each end with a metal chamber containing plates of 98.9 percent reflectance and 0.3 percent transmission in the range between 11,000 and 12,000 angstroms. An electrical discharge is induced through external electrodes connected to a 28-Mc generator. Energy from the internal discharge excites the helium atoms to a level from which they transfer energy to the neon atoms upon collision. A small portion of the excited neon atoms radiates spontaneously, thereby stimulating the remaining neon atoms to radiate a coherent stream of ir. The beam is reflected back and forth through the length of the tube by the semi-reflecting end plates, growing stronger with each trip. The small percentage of the beam transmitted through the plates forms the output beam. Strongest oscillation in the present laboratory model has been observed at 11,530 angstroms with an output power of 15 mw (input is between 50 w and 80 w). Angular spread of the beam is less than 1 minute of arc.

Up to 30 discrete frequencies can be emitted, ranging between 9,000 and 17,000 angstroms. Other gas mixtures are expected to produce different output frequencies.

Details of the gas maser are reported by A. Javan, W. R. Bennett, Jr. and D. R. Herriott in *Physical Review Letters*, Feb. 1.

Other companies known to be working on gas masers include IBM and TRG. Russian scientists are also reported to be working on a mercury-and-zinc gas maser. Papers on the Russian work are expected to be presented at the forthcoming Quantum Electronics Conf., March 22-24, in Berkeley, Calif.

Transducers and electrodes connected to airman are fed to airborne station (left, in photo) of physiological data acquisition system. Ground station equipment consists of digital control and readout units, and ecg and tape recorders (right), and Sanborn multichannel recorder (center)

Medical Data Telemetry System Unveiled

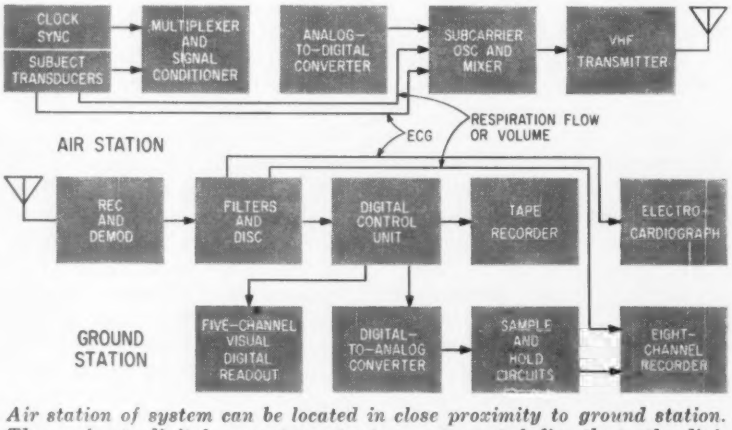
By WILLIAM E. BUSHOR
Associate Editor

HOLLOMAN AFB, N. M.—Scientists and physicians attending a space medicine seminar held here early this month were introduced to a new physiological data acquisition system developed by Gulton Industries. The system continuously measures 14 body parameters of high-altitude aircraft pilots and telemeters the data to a ground station for processing and recording.

Fourteen physiological parameters are detected with sensors developed by Gulton's Research and Development division. Seven temperature measurements (60 to 115 F) are made at various parts of the body with bead thermistors. Galvanic skin resistance or gsr (0 to 100 kilohms) is picked up by electrodes attached to the calf of each leg. Respiration flow (0 to 250 liters per minute) is detected by strain gages mounted in a face mask. Respiratory volume (0 and 100 liters) is determined by a chest band strain gage. Either respiration flow or volume is transmitted, but not both. Respiration rate (0 to 60 breaths per min) is derived from the respiration curve by using the inspiration wave fronts to trigger an electronic tachometer that converts the rate into a d-c average curve. Electrocardiograph or ecg signals are picked up by surface electrodes and amplified. Heart rate (0 to 300 beats per minute) is derived like breathing rate except that the R-wave spike of the ecg is used as a trigger. Systolic blood pressure (0 to 300 mm of Hg) is measured with a finger cuff and capacitor microphone that converts pressure to a d-c analog voltage. The signals from the sensors are amplified in the signal conditioner so they fall within the 0 to 10-volt range.

The airborne and ground station conversion and telemetering equipment was developed by Gulton's CG Electronics subsidiary. Analog voltages from eleven signal conditioner channels and the synchronizing clock signal are sampled by a mechanical multiplexer. Respiration volume or flow and ecg signals are fed directly to their subcarrier oscillators since they vary at frequencies much higher than can be reproduced with the time-shared digital system used. Ramp encoding is used in the analog-to-digital converter to produce non-return-to-zero (NRZ) digital signals representing each physiological parameter and the synchronizing signal in a three-digit seven-bit parallel code. The NRZ pulses drive a transistor voltage-controlled subcarrier oscillator for each parameter. Outputs from the subcarrier oscillators are then mixed. The combined signal modulates a vhf f-m/f-m transmitter.

At the ground station, the f-m/f-m signal is fed to discriminators that separate the subcarriers. The NRZ pulses are stored in the digital control unit until all three digits representing the value of a parameter are received. As each value is determined it is recorded on a tape recorder. The systolic blood pressure, gsr, heart and breathing rate, and any one of seven selectable temperatures are displayed on Nixie tubes in the digital readout unit. All digitized signals are also fed through an digital-to-analog converter to sample and hold circuits that sequentially select increments of each analog voltage and send them to a multichannel recorder. Respiration flow or volume is fed directly from the discriminator to the recorder, the ecg signal being sent to an electrocardiograph.



Air station of system can be located in close proximity to ground station. The analog-to-digital converter outputs are connected directly to the digital control unit, and the respiration flow or volume and ecg signals fed directly from the transducers to the graphic recorders

TEAMWORK IN PLANNING: Hallicrafters "BLUE STREAK" Teams support military programming groups for SAC aircraft at OCAMA and other materiel commands.

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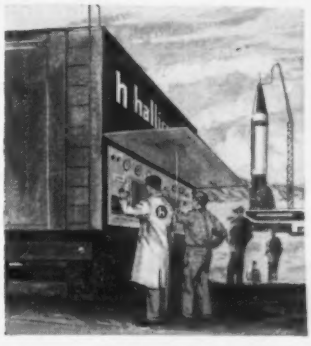

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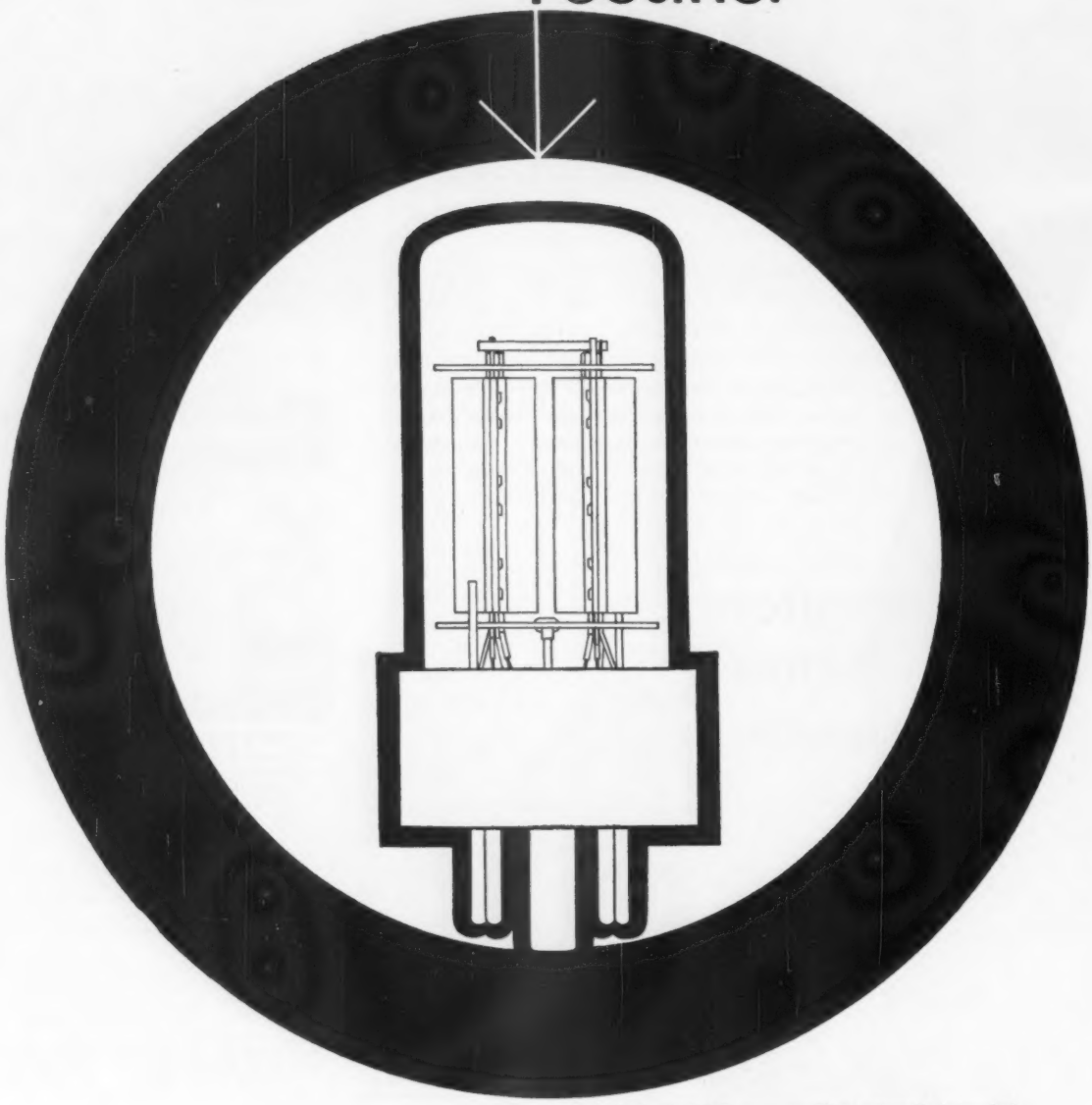

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Capacitor input				
$V_{a(r.m.s.)}$	2 x 450	2 x 500	2 x 550	V
I_{out} max.	250	200	160	mA
R_{lim} min. (per anode)	125	150	175	Ω

SUPPLIES AVAILABLE FROM:
IN THE U.S.A.
International Electronics Corporation
81 Spring Street, New York 12, N.Y. Worth 6-0790
IN CANADA
Rogers Electronic Tubes & Components
116 Vanderhoof Avenue, Toronto 17, Ontario. Hudson 5-8621

MULLARD OVERSEAS LTD., MULLARD HOUSE,
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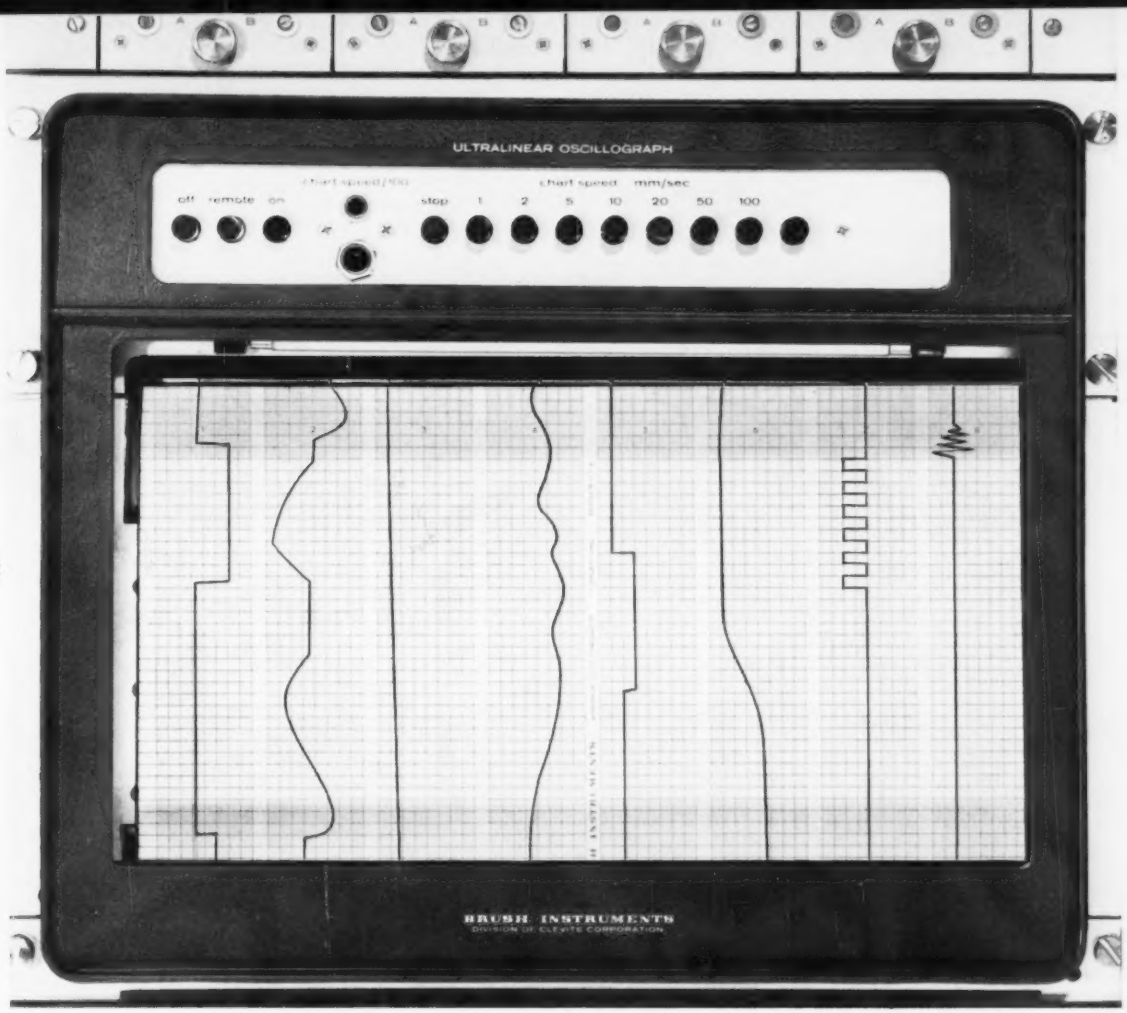
CIRCLE 35 ON READER SERVICE CARD→



in multi-channel recording systems there is nothing newer

. . . There are many reasons why Brush's newest oscillograph is the ideal choice for today's most advanced telemetry and computer systems. Its precision and reliability are proven. You get analog data instantly recorded on eight 40mm channels . . . and the sharpest traces on rectilinear coordinates you've ever seen. Thirteen electrically controlled chart speeds take the guesswork out of interpretation. *All* functions are operated by pushbutton . . . including an ingenious auto-load chart changing arrangement. But . . . the most important reason of all is that this vertical panel oscillograph carries the name "Brush". No one is as qualified. See for yourself. Call, write or wire.

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DIVISION OF CLEVITE CORPORATION
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How to hit the jackpot . . .

IF YOU HAVE A MOISTURE PROBLEM, Waters APW½ sealed potentiometer is so watertight and heat resistant, it operates reliably even in boiling water. Completely unaffected by humidity and water vapor, two common causes of pot failures in aircraft and missiles. Also available with servo face as Waters WPW½. Write for bulletin APW.

IF YOU REQUIRE A HERMETIC SEAL, Waters APH½, designed for soldering directly to the panel, not only maintains a hermetic seal behind the panel, but is itself tightly sealed against outside atmosphere and salt spray by means of double "O" ring shaft seal. Passes liquid immersion tests per MIL-E-5272A and, excluding the shaft, the Mass Spectrometer Test with leak rate less than 1×10^{-7} cc/sec. N.T.P. Write for bulletin APH.

IF YOU WANT TO READ A FUNCTION OF RESISTANCE DIRECTLY, Waters Dialpot® gives you the answers to these questions: Where is the slider? At what angle is the pot set? At what percentage of voltage is the pot set? Dial calibrated with equal graduations from 0 to 10 in the 300° winding angle. Scribe line on base. Plug-in feature is ideal for printed circuitry. Write for bulletin APD.

Waters

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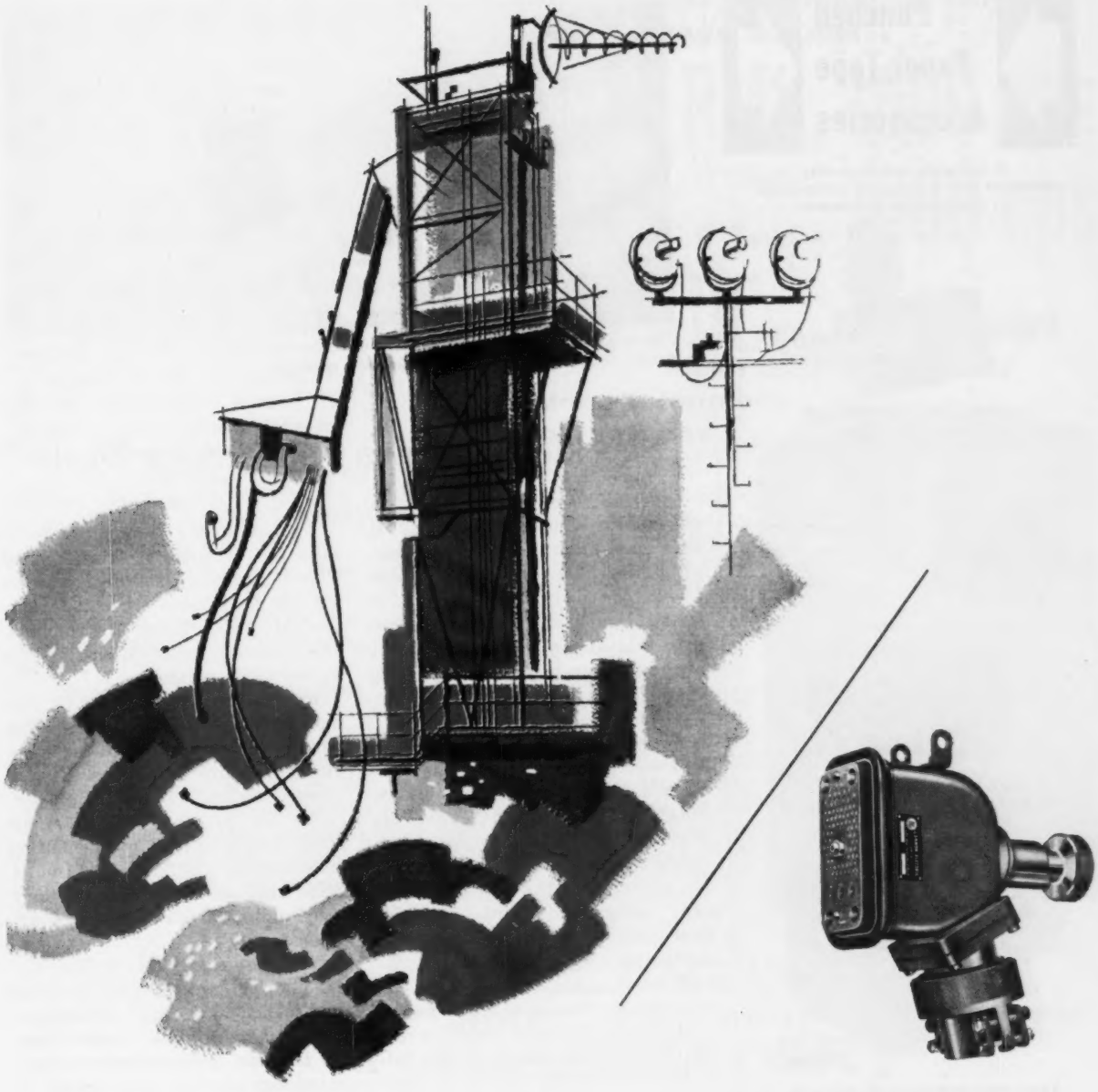

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FOR THE SPECIALIZED DEMANDS OF MISSILE LAUNCHING Cannon Umbilical Plugs are designed to provide the utmost reliability in connections between complex electronic systems within a missile and a master control point or other ground systems. Cannon is a pioneer in umbilicals and associated equipment; our research and development has kept pace with the expanding space program and can provide umbilicals to meet any challenge of missile launching. Our Phoenix Plant specializes in every phase of engineering, manufacturing, and testing—produces umbilicals compatible with any method of launching, any method of engagement and release. If you have standard or specialized launch requirements, consult the first name in plugs. Write for complete information to:

CANNON ELECTRIC COMPANY, 3208 Humboldt Street, Los Angeles 31, California

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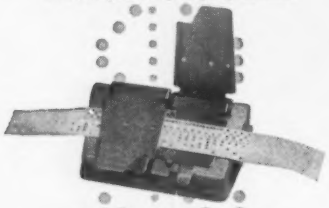
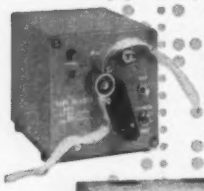
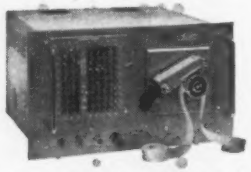


TAPE SPLICER NO. 219
Edits, Mends, Corrects.

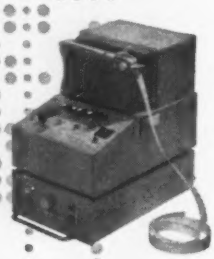


SINGLE LINE TAPE READER NO. 220
Reads up to 60 lines per second. 5, 6, 7 or 8 hole tapes.

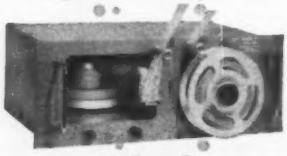


TAPE-ARD READER NO. 171
Reads 80 bits of information simultaneously.

Manual TAPE-ARD PUNCH NO. 173
Tape punch (uncoded)



TAPE-ARD DUPLICATOR NO. 174
(shown below punch)
For automatically duplicating punched tapes, use Duplicator No. 174, Tape Reader No. 171, and Tape-ard Punch No. 173.



TAPE-ARD HANDLING UNIT NO. 194
Handles 200 feet of one inch tape, no rewinding necessary.

Write for full information

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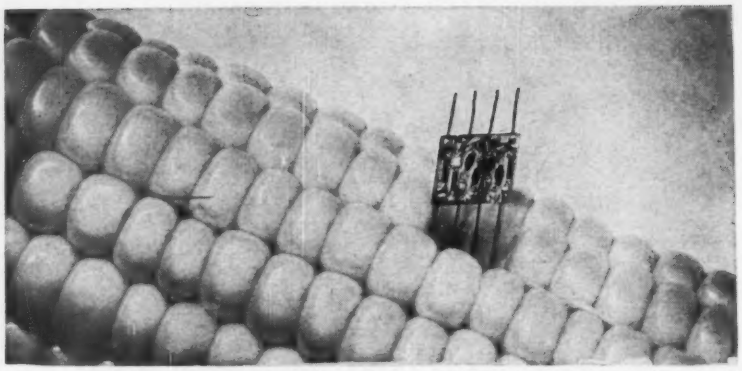

Seven operating components fit in unit size of kernel of corn, in Cleveland Metal Specialties' Micram packaging concept

Shockley Explains Four-Layer Diode

CLEVELAND—Highest frequency diodes now known shared the spotlight with low-level signal measuring methods, workshops on analog computer and digital measurements and a three-way display of microminiaturization during Cleveland's three-day eighth annual Electronics Conference here.

Four-layer diode capable of 20-30 nanosecond switching was explained by Dr. William Shockley, Shockley Transistor of Clevite, Palo Alto, Calif. "Most complex semiconductor now made," said Shockley, adding that the four-layer unit can integrate audio amplifier equivalent of five circuit elements (including two transistors) as built-in elements of solid-state circuit thinner than a sheet of paper.

Molecular five-watt amplifier was exhibited by Westinghouse in microminiaturization section of show which also featured discrete components fabricated by Cleveland Metal Specialties and components developed through vacuum deposition by Centralab and International Resistance Company. Show was attended by an estimated 5,000 scientists and engineers.

Military applications taking advantage of compact size and light weight are strongest prospects for four-layer diode to date, according to Shockley. Developed as crosspoint switching element to eliminate physical intrusion on local switchboards, the device has encountered problems of compatability with existing boards requiring high ringer currents.

Fast-switching tunnel diode is enjoying strongest sales among digital computer users interested in its 1-2 nanosecond switching time, Donald Able, Texas Instruments, Incorporated, reported during the tunnel diode workshop.

Hybrid circuitry TD's with vacuum tubes promise to become the most effective way to use these devices, according to Able's colleague James Shipley. TD's, although unstable in presence of changing power supply or load, overcome this disadvantage in hybrid circuits while keeping 90 percent of their speed and other advantages, he explained.

Workshop chairman Dr. Wen Ko, EE instructor at Case Institute of Technology, said these advantages include amplification range from d-c to kmc and performance approaching that of the maser in radar applications.

TD's withstand radiation one or two orders of magnitude better than other semiconductors and multifunction applications in communications permit simultaneous operation of the same unit at up to four different frequencies, Ko reported, with illustrations of simultaneous operation as oscillator, modulator and a-f amplifier and as demodulator, converter and local oscillator.

Noise figures have been disappointing for TD's, Shipley reported, missing the 2-db level predicted and approaching the 6-db of other transistors. Dr. Ko pointed out need for an isolator to help two-terminal device share

power and operating range among multiple functions.

"Flasher" circuit, to substitute for choppers within the next 3 to 4 years was announced by Dr. W. K. Volkers, Cohu Electronics, Schenectady, for introduction later this spring. Multicontact relay, reset every second, will save time wasted by choppers, according to Volkers.

Volkers also said a delay line tuner will be marketed by his company next spring. Volkers described "muscle rustle" detected by hush transistor circuit employed by medical electronics. Circuit deamplifies noise through degenerative load in emitter section, he said.

C. W. Carruthers, Raytheon, Boston, described photo chopper with improved efficiency as temperature advances from 30° to 85° C. Operation in optical range frees photo chopper from related r-f noise and, he said, the device also escapes bounce of mechanical units, he said.

"Micram", a Cleveland Metal Specialties concept which reduces the packaging of seven operating components to size of a kernel of corn, was among newest of displays in 96 booths by 61 manufacturers. Leece-Neville, Cleveland, exhibited exploded model of 40-amp alternator in Fansteel Metallurgical booth.

New PPI Console For British Shipping

LONDON—A new 16-in. display console introducing the interscan technique will make its appearance here this spring.

Made by Decca Radar Ltd., it provides a continuously visible electronic line which appears in the plan position indicator originating from the ship's own position.

From variations in length and direction of the displayed line, range and bearing information can be obtained rapidly and accurately on any number of targets and on any type of presentation.

The console is fitted with seven range scales extending from 0.75 to 60 miles, built-in true motion, brightness and contrast controls and a polarizing-sheet viewing hood allowing two operators to view the scope simultaneously.

Gives you accurate, continuously variable voltage outputs

0 to 10 v RMS, 1000 cps
0 to 10 v PEAK to PEAK, 1000 cps
0 to 10 v DC

Especially useful for checking accuracy of laboratory voltmeters and oscillographs

Ballantine's Model 420 Calibrator has proven to be an extremely useful instrument for quickly checking the calibration accuracy of voltmeters and oscillographs.

Its long term stability is such that you can rely on it for better than ¼% when using it with a calibration chart, and ½% without the chart. Accuracy checks can be made with it in less than a minute. This will help you to reduce materially the out-of-service time for voltmeters that otherwise might have to be sent to a central calibration department.

BALLANTINE MODEL 420—AC-DC CALIBRATOR

Price: $365

SPECIFICATIONS

Internal Impedance of Outputs: 2 to 20 ohms over range 0 to 10 v, 1000 cps output; less than 5000 ohms on dc output.

Distortion and Hum: Less than 0.25%.

Setting Resolution: Approaches 0.01% above 10 mv.

Power Supply: 115 v, 50-60 cps, 35 watts; 230 v, 50-60 cps on request.

Dimensions: 6" h, 6¾" w, 10⅞" d.

Write for brochure giving many more details

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CHECK WITH BALLANTINE FIRST FOR LABORATORY AC VACUUM TUBE VOLTMETERS, REGARDLESS OF YOUR REQUIREMENTS FOR AMPLITUDE, FREQUENCY, OR WAVEFORM. WE HAVE A LARGE LINE, WITH ADDITIONS EACH YEAR. ALSO AC/DC AND DC/AC INVERTERS, CALIBRATORS, CALIBRATED WIDE BAND AF AMPLIFIER, DIRECT-READING CAPACITANCE METER, OTHER ACCESSORIES.

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RADIO CORPORATION OF AMERICA

Makes Engineering Drawings In ½ Sec

COMPLEX ENGINEERING DRAWINGS can now be reproduced in one-half second from information supplied by a computer, according to Stromberg-Carlson Division of General Dynamics Corp.

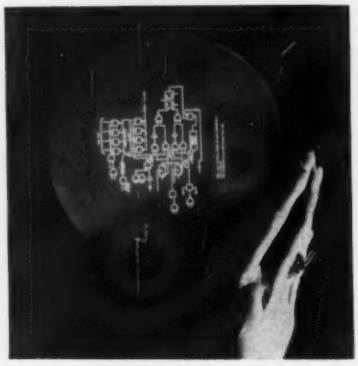
Using its new 4020 High-Speed Microfilm recorder the company is able to record data on microfilm at speeds of 17,500 characters per second, plot graphs at 12,500 points per second, and project selected data on a direct-view screen less than eight seconds after film exposure.

Heart of the 4020 system is the Charactron shaped beam tube. Impulses from magnetic tape pass through the printer's electronic circuitry, appearing as tv-like displays on the tube. Charactron reportedly provides highest intensity available in a cathode ray tube, and resolution of about 4 times that of a tv picture tube.

S-C's microfilm recorder provides engineering drawings and numerical controlled machine program almost simultaneously. Advantages are that design integrity can be inspected before part production, avoiding expensive mistakes. The system supposedly is applicable to any design that can be reduced to numerical parameters.

The designer completes conceptual design and puts it into numerical form so that a part programmer can convert the sketch into the language of Automatic Production Tool (APT), system developed at MIT for the Air Force. The translated program is then fed into high-speed computers and converted through a post processor to fit the specific machine upon which it will be used. The post processor converts general information on the tape into specific data on another magnetic tape for the particular control system on the machine. This second tape runs the machine tool.

When the first data tape is being processed through computer in conjunction with the numerical machine control post processor, it is also being processed in conjunction with a post processor for the S-C 4020. A new magnetic program tape is produced for control of the 4020 which produces engineering drawings from this program.



This complex logic circuit diagram was automatically drawn with electron beams on face of 7-in Charactron shaped beam tube

Utilizing a standard high-speed computer, a conventional numerical machine control sub system and a S-C drawing production sub system, the signal input system completely defines the part in terms of dimensions, tolerances, materials, and other pertinent data required to make the part.

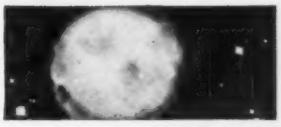
The input signal is generated from the design numerical parameters, dimension calculations by the computer and standard conditions fed into the signal carrier at post processing position. Input signal defines the part on the face of high resolution, high intensity crt. A 35mm camera records the image produced on face of crt. From this film record, standard prints are possible for design integrity or inspection of parts finished by the numerical machine control sub system.

Agencies Invite Proposals For Nuclear Rocket Engine

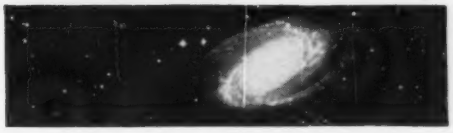
ATOMIC ENERGY COMMISSION and National Aeronautics & Space Administration recently invited proposals for research and development on a nuclear rocket engine.

Experiments have been going forward on the KIWI reactors at Los Alamos for some time; KIWI A3 was successfully ground-tested last October.

WE'RE REACHING INTO SPACE



Bell Laboratories research with chilled ruby amplifiers speeds the day we may telephone via satellites



A strange combination of Nature's forces at Bell Laboratories foreshadows the day when world-wide phone calls may be relayed via man-made satellites orbiting the earth. It is a union of synthetic rubies and extreme cold, making it possible to amplify microwave signals from these satellites clearly.

Synthetic rubies possess an extraordinary property when deeply chilled and subjected to a magnetic field. They can be excited to store energy at the frequencies of microwave signals. As a signal passes through an excited ruby, it releases this energy and is thus amplified a thousandfold.

Bell Laboratories scientists chose a ruby amplifier because it's uniquely free of "noises" that interfere with radio signals. For example, it doesn't have the hot cathodes or hurtling electrons that generate noise in conventional amplifiers. It is so quiet that only the noise made by matter itself in heat vibrations remains. But at a temperature close to absolute zero, this also is silenced. Even very faint signals from satellites can be clearly amplified and studied for their possibilities.

Bell Laboratories scientists were first to discover that matter itself generates electrical noise. They also discovered that stars send radio waves, and thus helped found radio astronomy. It is particularly fitting that the same scientists, in their endless research on noise, should now battle this number-one enemy of telephony in the dramatic new field of communication via satellites. The ultimate goal, as always, is the improvement of your Bell System communications services.

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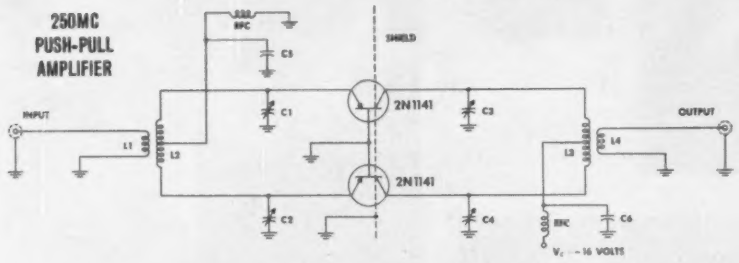
HOW TO SOLVE HIGH GAIN LOW NOISE AMPLIFIER PROBLEMS

Specify TI 2N1141 series or TI 2N1405 series
P-N-P Germanium Mesa High-Frequency Transistors

250MC PUSH-PULL AMPLIFIER



Use TI 2N1142 transistors if only 330 mw output is required.

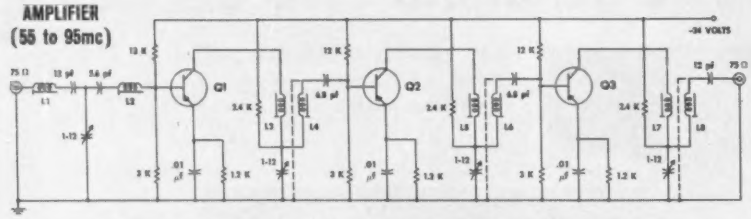
Power in = 20 mw
Power out = 380 mw
V_{CB} = −25 v
I_c = 35 ma

C1, C2, C3, C4 = 3–12pf CTC Trimmer Cap.
C5, C6 = 1000 pf Sprague T. V. Bypass Cap.
L1 = 4 turns No. 18 tinned copper wire; 5/16" diam; 1/2" length
L2 = 6 turns No. 18 tinned copper wire; 3/8" diam; 1/16" length
L3 = 6 turns No. 18 tinned copper wire; 3/8" diam; 1/16" length
L4 = 2 turns No. 18 tinned copper wire; 5/16" diam; 1/4" length

Design-in Texas Instruments 2N1141 series transistors to obtain 380 mw output at 250 mc from your power amplifiers in telemetering applications in missiles and military communication systems.

Texas Instruments 2N1141, 2N1142, 2N1143 germanium mesa transistors providing maximum dissipation of 750 mw at 25°C case temperature, 35 volts at 100 μa I_C, and f_{max} to 750 mc, are *ideal* for your VHF power amplifier and oscillator circuits.

40MC BANDWIDTH AMPLIFIER (55 to 95mc)

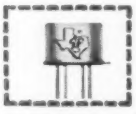


PERFORMANCE CHART

Q1	Q2	Q3	Gain (db)
2N1405	2N1405	2N1405	30
2N1405	2N1406	2N1406	27
2N1405	2N1406	2N1407	23
2N1405	2N1407	2N1407	20

L1, L8 9 TURNS #24 ENAMEL WIRE CLOSEWOUND ON CTC LS9
L2, L4, L6 10 TURNS #32 ENAMEL WIRE CLOSEWOUND ON CTC LS9
L3, L5, L7 20 TURNS #37 GRIPEZE CLOSEWOUND ON CTC LS9

INPUT 30 μv
V_{cc} 9v
I_c 4.2 ma



This 40-mc bandwidth amplifier is an outstanding example of using Texas Instruments 2N1405 series transistors to obtain 30-db gain and compensate for cable losses in transmission line systems. These devices which have noise figures as low as 5 db at 200 mc will also provide similar functions in *your* line and video amplifiers, r-f and i-f amplifiers and mixer-oscillators.

The 2N1405, 2N1406 and 2N1407 give you *the best high frequency/low noise/high power gain* combination in the industry and are now available from TI in production quantities.

Check these specifications and select the **particular** germanium mesa **transistor** that meets your **specific requirements.** All 2N1141 series and 2N1405 series devices are stocked in depth by your authorized TI distributor. Call him or your TI sales engineer **today** for price and delivery information plus detailed reports on 2N1141 and 2N1405 applications.

TYPICAL CHARACTERISTICS AT 25°C	2N1141	2N1142	2N1143	2N1405	2N1406	2N1407
TYPICAL COMMON-EMITTER SHORT CIRCUIT FORWARD CURRENT TRANSFER RATIO AT 100 mc h_{fe}	13.5 db	11.5 db	9.5 db	10.0 db	10.0 db	7.5 db
TYPICAL NOISE FIGURE AT 200 mc N.F.				5.0 db	6.0 db	7.0 db
TYPICAL MAXIMUM FREQUENCY OF OSCILLATION f_{max}	750 mc	600 mc	500 mc	1100 mc	750 mc	650 mc
TYPICAL COLLECTOR-BASE TIME CONSTANT $r_b' C_c$	30 ohm-$\mu\mu$f	40 ohm-$\mu\mu$f	50 ohm-$\mu\mu$f	12 ohm-$\mu\mu$f	25 ohm-$\mu\mu$f	25 ohm-$\mu\mu$f

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2N1405 series

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DALLAS, Texas
AD 5-2381
DAYTON 39, Ohio
AX 8-7513
DENVER 3, Colorado
AM 6-3675
DETROIT 19, Michigan
KE 5-8390
DOWNEY, California
WA 3-4521
ELIZABETH, New Jersey
EL 4-6800 MU 2-7951
ENDICOTT, New York
ST 5-9987
FT. WAYNE, Indiana
HA 4251
GARDEN CITY, L. I., New York
PI 2-1515
GRAND RAPIDS, Michigan
CH 1-4468
HOUSTON, Texas
JA 2-7961
HUNTSVILLE, Alabama
JE 9-2891
INGLEWOOD, California
OR 4-9333
MILWAUKEE 16, Wisconsin
HO 4-8780
MISSION, Kansas
CO 2-9535 (Kansas City Excg.)
ORLANDO, Florida
GA 2-9894
PALO ALTO, California
DA 6-6770
POUGHKEEPSIE, New York
GR 1-6095
REXDALE, Ontario
RO 6-6429
ROCHESTER, New York
HI 5-0070
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PA 1-2169
ST. PAUL 4, Minnesota
MI 6-2755
SALT LAKE CITY, Utah
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MA 3-6870
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GR 6-4031
WELLESLEY HILLS 81, Mass.
CE 7-9750
WASHINGTON 5, D. C.
FE 7-6400

MEETINGS AHEAD

Feb. 20-25: Semiconductor Exposition, International, Societe Francaise des Electroniciens et Des Radio-Electriciens; Maison de L'Unesco, Paris.

Feb. 26-Mar. 1: Pacific Electronic Trade Show; Great Western Exhibit Center, Los Angeles.

Mar. 1-2: Instruments Show, ERA; Elks Club, Palo Alto, Calif.

Mar. 1-2: Society of Vacuum Coaters, Thin-Film Structures; Conrad Hilton Hotel, Chicago.

Mar. 6-8: Data Processing Conf. & Exhibit, AMA; Statler-Hilton Hotel, Wash., D. C.

Mar. 9: National Federation of Science Abstracting & Indexing Services; Manger Hotel, Cleveland, O.

Mar. 9-10: Engineering Aspects of Magnetohydrodynamics, PGNS of IRE, AIEE, IAS; University of Penn., Philadelphia.

Mar. 11: Quality Control, American Society for; Hart House, Univ. of Toronto, Ontario.

Mar. 14: Defense Planning Seminar, EIA; Statler-Hilton Hotel, Wash., D. C.

Mar. 15-19: High-Fidelity Show, Magnetic Recording Industry Assoc.; Cow Palace, San Francisco.

Mar. 20-23: Institute of Radio Engineers, International Convention, All PG's; Coliseum & Waldorf-Astoria Hotel, New York City.

Mar. 21-22: Institute of Printed Circuits, Annual; New York City.

Mar. 27-31: Temperature, Its measurement and Control, ISA, AIP, NBS; Veterans Memorial Auditorium, Columbus, O.

Apr. 4-6: Electromagnetics and Fluid Dynamics of Gaseous Plasma, IRE, IAS, U. S. Defense Research Agencies; Engineering Societies Bldg., New York City.

IMAGINE!

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NEW C1K, C3J and C6J

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with exclusive

Cetron Milled Grid

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- Increased Reliability!
- Matched Characteristics!
- More Hours Per Dollar!
- Flying lead, lug or base mounting!

For improved performance in welding, precipitators, static spray equipment, induction heating, diathermy and other pulsating circuit equipment.

	Anode Avrg. Amps.	Current Peak	Peak Voltage Forward/Inverse		Grid Voltage Grid Volts/Anode Volts	
C1K	1.0	8.0	1000	1250	—4.5	1000
C3J	2.5	30.0	900	1250	—5.7	900
C6J	6.4	77.0	750	1250	—3.5	750

Capable of meeting all requirements of JAN Military Specifications

Cetron engineers are always available to help in your tube requirements—just write, wire or phone.

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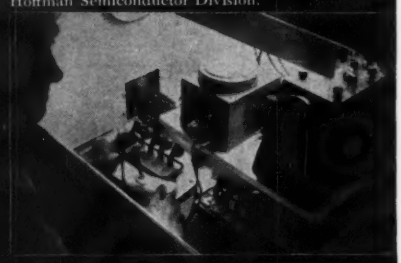


This dry box, pressurized with inert gas, typifies the contaminant-free production environment at Hoffman Semiconductor Division.

Hoffman CERTIFIED SURVIVAL RATE*

—a fresh angle on semiconductor reliability

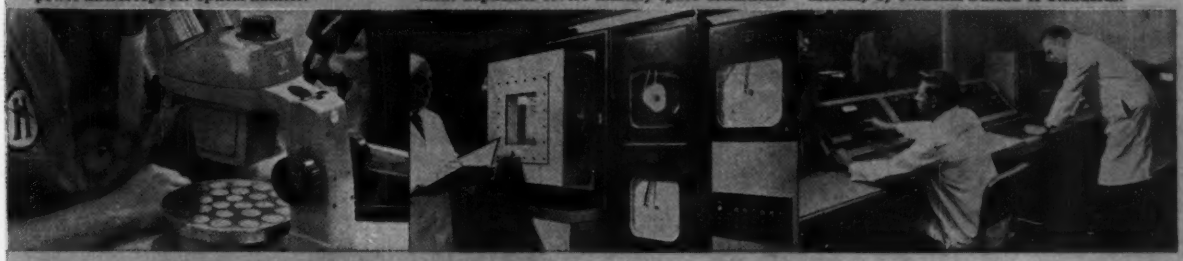
*Tests Conducted Under Military Surveillance and Certified by Hoffman Reliability Engineers

The statistical graphs presented here are taken from certified records of the Hoffman Reliability and Statistical Engineering Department, Evanston, Illinois. Hoffman tests are conducted under the surveillance of a resident military inspection team. Reliability data on 1N429 zener reference diodes is available on request.

Constant production checks ensure final excellence. Here silicon wafers are inspected with high-power microscope for optical flatness.

Devices under environmental life test are continually monitored by laboratory personnel. Equipment duplicates severe military-space conditions.

All production and test instruments are calibrated from this control console which, in turn, is checked monthly by National Bureau of Standards.

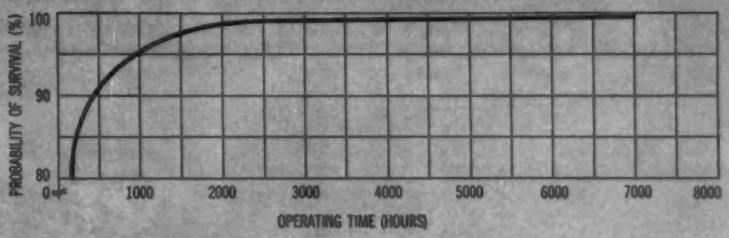


SURVIVAL RATE

At the right is a picture of survival. It depicts the life expectancy of Hoffman silicon zener reference devices, based on continuing tests of representative samples selected from thousands of production units. These samples are tested at 100°C without derating from specifications. Mean time between failures based on a 90 percent customer confidence factor—"failure" meaning any deviation beyond specification tolerances—is 188,477 hours! Life test data indicates mean time between catastrophic failures to be 565,431 hours (as of December 31st, 1960).

PROBABILITY OF SURVIVAL

with 90% confidence for the 1N429 units

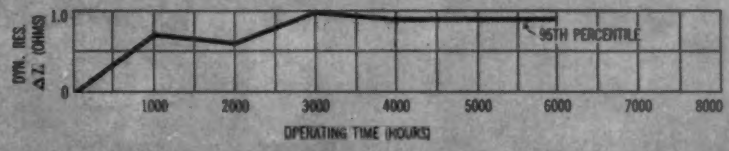


PARAMETER STABILITY

These graphs can help you build more reliable equipment with Hoffman devices by permitting you to take into account parameter stability during service life. Although the graphs represent just one type of unit, the 1N429 zener reference diode, the high survival rate and parameter stability are indicative of the degree of reliability built into all Hoffman devices. Research, development, advanced manufacturing techniques, and statistical quality control all provide assurance that the Hoffman products you buy will perform their intended service with maximum reliability.

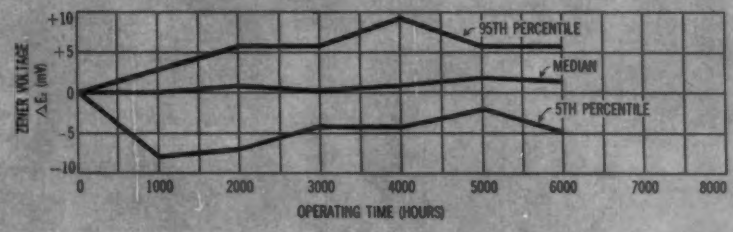
DYNAMIC RESISTANCE

This curve represents the maximum increase in zener resistance experienced by 95 percent of the units tested.



ZENER VOLTAGE

The 5th and 95th percentile curves denote the boundaries for the change in zener voltage (referenced to the initial values) experienced by 90 percent of the units. A visual examination of the median reveals the high degree of stability obtained by the Hoffman devices.



Hoffman

Hoffman / ELECTRONICS CORPORATION

Semiconductor Division

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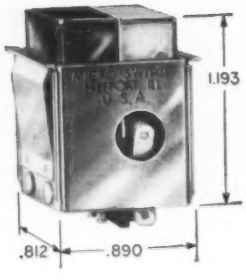
MICRO SWITCH Precision Switches

FULL COMMAND IN ONE CUBIC INCH!



NEW MINIATURIZED LIGHTED PUSH-BUTTON SWITCHES SAVE PANEL SPACE

The new "302PB" Series combines control and visual indication in one completely assembled unit that requires less than one cubic inch of panel space. These miniaturized lighted push-button assemblies can be mounted or removed without tools.

The display screen, mounting flanges and two single-pole double-throw basic switches are all integral components, permanently assembled to make a mechanically strong unit built for long life. Fifteen display screen color combinations are available, obtained by use of a split screen. A separate miniature lamp illuminates each half of the screen. These lamps are designed for infinite service life. "302PB" Series switches conform to the applicable requirements of MIL-S-6743, MIL-S-6744 and MIL-E-5272A. Check the nearby MICRO SWITCH Branch Office, listed in the Yellow Pages for full information or write for Data Sheet 182.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls Limited, Toronto 17, Ontario

Honeywell
MICRO SWITCH Precision Switches

46 CIRCLE 46 ON READER SERVICE CARD

The newest Mincom magnetic tape instrumentation recorder / reproducer, to be announced in detail next month, answers the need for better performance in the intermediate frequencies. Covering bandwidths from 200 cps to 300 kc at 60 ips with improved dynamic range, it fills the gap between Mincom's Model C-100 (125 kc-60 ips) and the Model CM-100 (1 mc-120 ips). The new model also is extremely versatile, offering both FM and Direct recording / reproducing. One-rack compactness, all-transistorized electronics. Wait and see more of this new system's extra capabilities.

3M COMPANY ... WHERE RESEARCH IS THE KEY TO TOMORROW

MINCOM DIVISION MINNESOTA MINING AND MANUFACTURING COMPANY

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TANTALUM CAPACITORS...NEW HEIGHTS IN RELIABILITY

ENGINEERED BY PYRAMID

When Pyramid tantalum capacitors with proven dependability are incorporated into essential electronic equipment you manufacture... greater reliability of your product is assured.

To design engineers searching for miniature electrolytic capacitors with unusual capacitance stability and a low dissipation factor over a wide temperature range, soundly constructed tantalum capacitors are gratifying discoveries.

If the equipment you make demands small capacitors with explicit reliability and peak performance, look to Pyramid for tantalum capacitors that meet your most exacting requirements.

For full details write or call: Sales Department

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SEE US AT I.R.E. BOOTH 1212

CIRCLE 48 ON READER SERVICE CARD

CIRCLE 49 ON READER SERVICE CARD →

IMPACT!

This is a "warhead". It's the front end of a carrier which darts through a pneumatic tube system at speeds up to 20 mph, and is subject to frequent shocks and impact. There's a story behind the choice of LEXAN® polycarbonate resin for this new design . . .

Formerly, destinations were set by contacts along the entire body of the carrier. Engineers of Airmatic Systems Corporation, Saddle Brook, New Jersey, reasoned that if all the control elements could be fitted into a small impact- and wear-resistant head, the rest of the carrier could be designed for easy maintenance and quick replacement. Many plastics had the required dielectric strength, but none could measure up to LEXAN resin's combination of good electrical properties, excellent dimensional stability and extremely high impact strength. LEXAN resin actually withstands over 12 foot-pounds per inch of notch — an impact strength attained by no other plastic!

The new warhead is injection-molded of black LEXAN resin by Berkeley Engineering & Manufacturing Co., Berkeley Heights, N. J. Now when wear and tear take their toll, the transparent carrier body is easily replaced, since it has no control elements. Also, body length can be varied to suit customer needs, and carrier weight is reduced. Printed circuits and compactly arranged brushes and control plates are used. The new design is more attractive, more practical, less costly. And—LEXAN resin warheads have proved in field tests to last longer than the old control units.

G.E. LEXAN polycarbonate resin has raised the quality of many designs to new levels. It has been reduced in price approximately 40% over the past year! Can this tough, new thermoplastic help you? Send for design literature.

LEXAN®
Polycarbonate Resin

GENERAL ELECTRIC

Chemical Materials Dept., Section E-11, Pittsfield, Mass.

SILICONE NEWS from Dow Corning

Build In Reliability

Seal Out Moisture and Humidity with Silastic RTV

Reliability of equipment starts with materials. Dow Corning Silicones have physical and electrical properties that mean extra reliability for electronic components, assemblies, systems.

For example: Silastic® RTV, the room temperature vulcanizing Dow Corning silicone rubber, is highly resistant to ozone, corona, weathering and oxidation. Heat-stable, Silastic RTV remains operable from —60 to 250 C; has good dielectric and physical properties.

Major uses for Silastic RTV include potting, filling, and encapsulation of electronic components and assemblies. Since it is a liquid, Silastic RTV pours easily to form a void free, rubbery mass around components. Available in several grades, Silastic RTV has set-up times ranging from several minutes to hours. Encapsulated parts can be handled in 24 hours, filled parts in even less time.

As a seal against humidity and salt water spray, Silastic RTV is used by Automatic Power, Inc., Houston, Texas to embed all tube sockets, connections, electronic components and wiring in the chassis of the control panel for their Dies-L-Air Automatic Warning Signal. This interchangeable control panel monitors operation of the entire warning signal system — including a diesel engine driving an integral air compressor, an air system, the control circuitry and air blast horns. Used to alert sea traffic to the presence of off-shore drilling equipment, reliability requirements for Dies-L-Air are continuous — and most critical during storms when the unit is being whipped by corrosive salt water spray and lashed by wind-driven rain. By sealing the control chassis with Silastic RTV, Automatic Power, Inc., has assured the reliabilty of electronic components.

CIRCLE 289 ON READER SERVICE CARD

For "Silicones for the Electronic Engineer", Write Dept. 3514

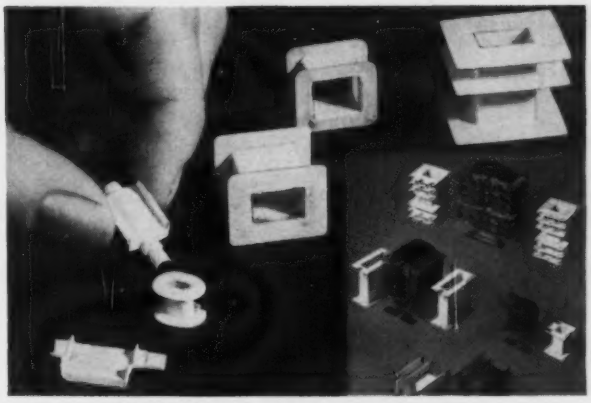
first in silicones

Dow Corning

...Specify Silicones

Laminates Give Extra Strength

Silicone-glass laminates, made with Dow Corning resins, have dielectric properties at high temperatures that are superior to those of other laminate materials. They resist ozone, arcing, corona, fungus — even the combination of high humidity and high voltage. Mechanical strength is good — permitting thin, rigid coil bobbin walls; more winding space and better resistance to winding pressure. These are the reasons why Foster Transformer Company, Cincinnati, Ohio, specifies coil bobbins of silicone-glass laminates for transformers they manufacture for airborne guidance control systems. The one-piece coil bobbins, like those shown, are used in continuous operation at 250 C . . . tested for 1000 hours at 400 C.



CIRCLE 290 ON READER SERVICE CARD

Improve Transistor, Diode Performance

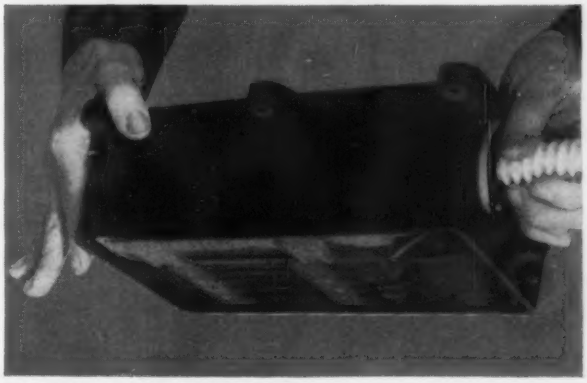
Used in mounting diodes to heat-sink or to chassis, Dow Corning Compound forms an excellent heat-sink seal . . . is easy to apply and never dries out. Its good thermal conductivity improves the heat transfer between diode-and-washer, washer-and-chassis.

Dow Corning silicone compounds don't melt, lose their grease-like consistency or dielectric properties from —70 to 200 C. Dow Corning silicone compounds have been found ideal for potting transistors. They cushion junctions against shock and vibration . . . improve heat dissipation because of their good thermal conductivity. Transistor junctions are not contaminated by Dow Corning's transistor potting compound . . . rejects from metal splatter are reduced when welding on transistor caps.

CIRCLE 291 ON READER SERVICE CARD

New Gel for "See Through" Protection

Poured as a liquid, transparent Dow Corning Dielectric Gel fills all voids, then sets up to form a heat-stable gel. Dielectric strength is excellent; stress on components almost nil. Potted components and circuitry remain clearly visible . . . can be checked by eye. Probes can be inserted for instrument checks . . . the gel re-seals itself when probes are removed. Individual components can be replaced. Dielectric Gel enabled CBS Laboratories to meet stringent reliability requirements on its Photoscan power supplies. Despite high temperatures, high voltages, and high vibration levels in this remarkably small unit, Dielectric Gel prevents arcing. Components are spaced less than ¼" apart, yet output voltages run from 1,000 to 25,000 volts!



CIRCLE 292 ON READER SERVICE CARD

CORPORATION MIDLAND, MICHIGAN

branches: ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

WHY PERMANENT MAGNETS ARE PERMANENT!

Study of Remanence by Indiana Steel indicates 100% stability can be achieved

Truly permanent permanent magnets are now possible, according to scientists of Indiana Steel Products Division, Indiana General Corporation. Proof of 100% stability of remanence was gained during a special research project conducted by Indiana and supported by funds of the United States Air Force.*

Natural Stability

Materials having a high coercive force displayed the greatest natural stability. For example, a sample of non-oriented barium ferrite (INDOX I) with an H_c of 4,000 oersteds was measured for natural stability over a period of more than 5,000 hours. Relative remanence was 100% ±0.1%. An oriented sample of the same material (INDOX V) with an H_c of 2,030 oersteds measured 99.5% ±0.1%. The material having the lowest coercive force—ALNICO III — also exhibited the least natural stability, 97.04% ±0.05%.

A second important factor affecting natural stability was length-to-diameter ratio (L/D). It was found that rods of ALNICO V, having a greater L/D ratio, proved more stable. For example, rods with a ratio of 8.7:1 showed *no* detectable loss in remanence during a year. Rods with an L/D of 2.1:1 logged only 97.6% for the same period.

Where change in remanence was perceptible, it was found that it decreases linearly with the logarithm of time (see figure 2). This relation is expected to hold for all permanent magnets when they are undisturbed at room temperature and made of a material which does not change with time.

Test Conditions

During the study, sample magnets were kept in a special room where they were relatively free from such external demagnetizing influence as temperature variations, stray magnetic fields, short circuiting by iron contact and excessive movement or handling. Temperature was held virtually constant at 24° ±2.5°C.

The sensitive measuring apparatus was also located in the test room. Developed in 1948 by Dr. Rudolph Tenzer of Indiana Steel, this equipment permits measurements to an over-all tolerance of better than 1 in 10,000.

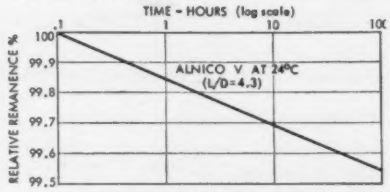
Contract AF33 (616) — 3385 monitored by the Aero. Res. Lab., WADC.

FIGURE 1. Summary of Experimental Results

Material	L/D	Remanence Bd kilogauss	Stability Relative Remanence at 24° C 5 log cycles (10,000 hr) after magnetization	Measuring Accuracy
INDOX I	0.9	1.4	100.0%	± .1%
INDOX V	0.8	2.5	99.6	± .1
ALNICO III	3.5	4.5	98.10	± .04
	2.2	3.2	97.04	± .05
ALNICO VII	3.5	4.9	99.32	± .04
	2.2	3.9	98.96	± .06
ALNICO V	8.0+	12.3	99.95	± .01
(long)	5.8	11.9	99.81	± .02
(medium)	4.3	10.4	99.23	± .02
(short)	3.5	8.2	98.84	± .04
	2.9	6.7	98.50	± .05
	2.1	4.1	97.6*	± .07

*Extrapolated 1 to 2 log cycles beyond last measurement.

FIGURE 2. Remanence decreases with time



Artificial Stabilization

Critical space-age applications often require that a magnet be completely stabilized. Many methods for achieving this were surveyed. For critical applications, methods based on repetitive processes were found superior to those based on any sudden, one-time action. Two of these proved successful, both involving artificial reduction of remanence.

1. **Temperature Knockdown.** ALNICO V magnets were repeatedly exposed to temperatures above and below the temperature of magnetization. Several cycles improved magnetic stability, while remanence was reduced somewhat as a result. Low temperature exposures, to −65° C, produced the greatest improvement in stability, as well as the greatest reduction in remanence.
2. **Knockdown by Applied AC Field.** ALNICO V magnets were subjected to a cycling diminishing field, which also caused a reduction in remanence. Depending upon the material and its use, magnets were knocked down a predetermined amount between 5 and 15% to achieve complete stability. Variations in remanence were less than ± 0.03%, which is the limit of measuring accuracy for this size sample.

Conclusions

This study indicates that permanent magnets *can* be completely stabilized. A magnet, however, that is perfectly stable under these conditions can still be affected by larger temperature variations, stray magnetic fields, vibrations or many other factors. In the case of selected magnets, stability *can* be guaranteed for a flux change no greater than 0.01% per year.

For complete information on the practical aspects of "Stability," ask for a copy of *Applied Magnetics*, First Quarter, 1959. Write Dept. A-2.

DIVISION OF INDIANA GENERAL CORPORATION

INDIANA STEEL PRODUCTS

VALPARAISO, INDIANA

In Canada: The Indiana Steel Products Co. of Canada Limited, Kitchener, Ontario

INDIANA PERMANENT MAGNETS

CIRCLE 53 ON READER SERVICE CARD→

NEW UNIVERSAL SPECTRUM ANALYZER

Polarad Model SA-84W being used to make pulse analysis of radar aboard a Pan American Boeing 707, Jet Clipper®

MODEL SA-84W 10 to 44,000 MC in a single unit

FEATURES:

A Over 80 mc dispersion
1 mc to over 80 mc for narrow pulse analysis.

100 kc to 7 mc for wide pulse analysis.

A Dual Resolution
7 kc or 50 kc automatically set by dispersion control.

B Crystal controlled markers from 10 to 44,000 mc.

C Provision for use with a multi-pulse spectrum decoder (Polarad Model SD-1)

D Log-linear amplifiers

E Expanded, direct-reading, slide rule dial.

F Accurately calibrated IF attenuator

The Polarad Model SA-84W is the most accurate universal microwave analyzer to measure nearly all parameters — Pulse, CW, FM, VSWR, antenna patterns, bandwidths and filter characteristics.

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MAIL THIS CARD for specifications. Ask your nearest Polarad representative (in the Yellow Pages) for a copy of "Notes on Microwave Measurements."

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Please send me information and specifications on:

POLARAD

☐ Model SA-84W Universal Spectrum Analyzer
☐ Model SD-1 Multi-Pulse Spectrum Selector (see reverse side of page)

My application is_____

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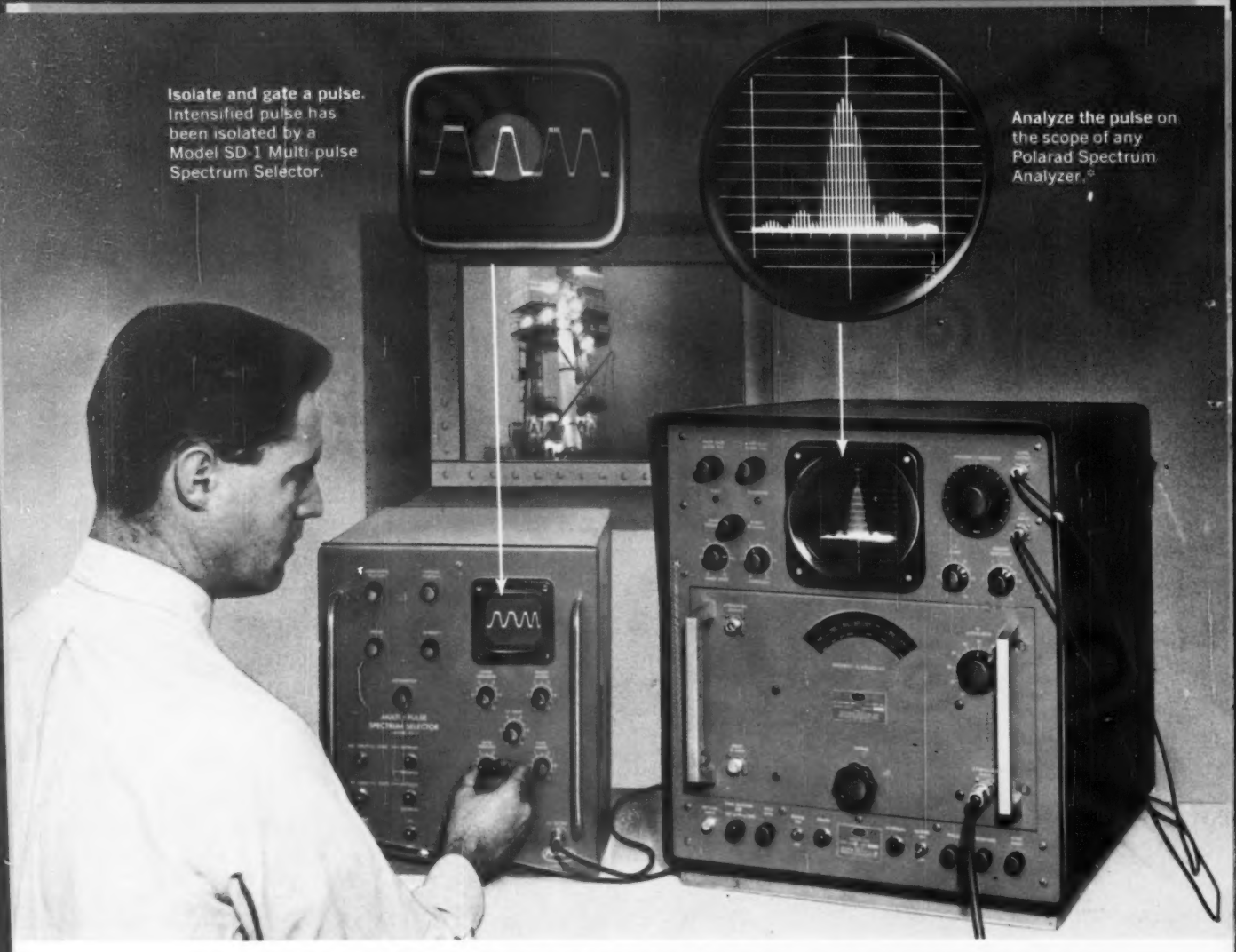
Isolate and gate a pulse. Intensified pulse has been isolated by a Model SD-1 Multi-pulse Spectrum Selector.
Analyze the pulse on the scope of any Polarad Spectrum Analyzer.*

COMPLEX SPECTRUM DECODING

10 to 44,000 mc.

Signal Analysis for Missiles, Telemetry, IFF, Beacons and Radar

The Polarad spectrum selector permits spectrum analysis and decoding of any selected pulse within a multiple pulse train. Sweep, gate width and position can be controlled. Model SD-1 permits the selection and gating of a group of pulses up to 180 μsec. in length (Model SD-IX permits 350 μsec.)

Works with POLARAD Models TSA, TSA-S, TSA-W, SA-84 and SA-84W spectrum analyzers.

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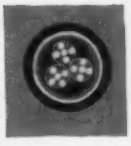
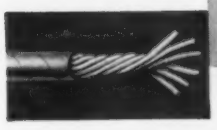
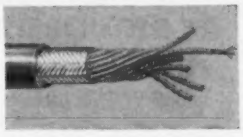
Are lines A and B parallel?







At Hitemp–Quality is not an illusion

Examine with the naked eye and handle several different brands of wire and cable. They look and feel identical, don't they? Their similarity with regard to quality, however, is just as much an illusion as the art form above.

Though different brands may be made with similar materials and equipment, one brand of wire and cable will outlast, outperform all others. That brand is Hitemp.

Why? Because Hitemp has the greatest store of experience in the industry—two modern production facilities that are second to none—and more than one-fourth of its entire work force devoted solely to inspection and quality control.

Hitemp products are for you, the wire and cable user who requires quality and reliability that is fact, not illusion.

Hitemp is a Division of Simplex Wire & Cable Co.

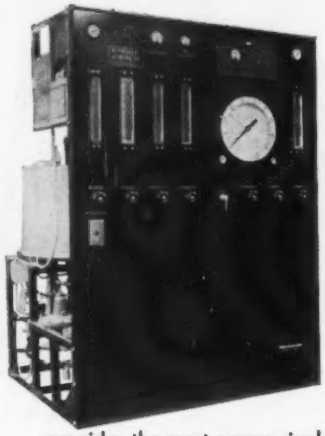
HITEMP WIRES CO.

1200 SHAMES DRIVE, WESTBURY, NEW YORK
1532 S. CALIFORNIA AVE., MONROVIA, CALIF.

FOR DETECTION AND MEASUREMENT OF OXYGEN IMPURITIES IN OTHER GASES

In metallurgical and chemical processes requiring an oxygen-free atmosphere, the Minoxo Indicator provides a means of insuring that failure of purification or ingress of atmospheric oxygen through an unsuspected leak does not cause costly spoilage. The Minoxo Indicator . . . measures traces of molecular oxygen in other gases—from 0 to 10 parts per million, and from 0 to 100 PPM. High sensitivity and rapid speed of response enable it to be used for laboratory investigation and production quality control.

INDUSTRIAL EQUIPMENT DIVISION
GAS EQUIPMENT SECTION
113 ASTOR STREET • NEWARK, N. J.



A GAS GENERATOR FOR THE MOST EFFICIENT AND ECONOMICAL PRODUCTION OF N_2 H_2 FORMING GAS MIXTURES

. . . provides the most economical and efficient method for the production of pure nitrogen—*completely free of oxygen*—with a hydrogen content precisely controlled at any desired percentage between 0.5% and 25%. Gas mixtures are supplied at a fraction of cylinder supply cost. • The Nitroneal Generator is automatic except for startup, with no need for operating personnel. The unit performs instantly, efficiently anywhere in the range of from 25% to 100% of rated capacity. Installation requires only a 110 volt line, water, air, ammonia lines and drain facilities. . . . The catalyst lasts indefinitely–minimum maintenance costs.

INDUSTRIAL EQUIPMENT DIVISION
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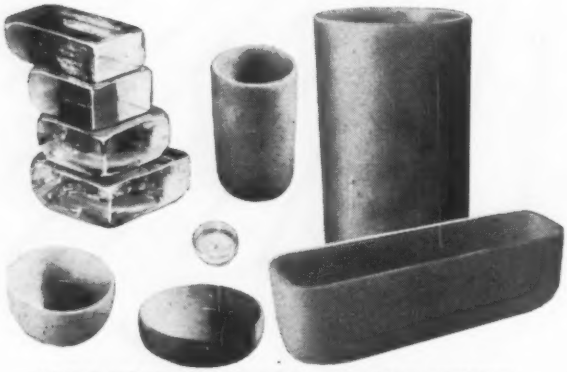

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Amersil manufactures and fabricates high purity fused quartz for ultraviolet transmission application, laboratory ware and production equipment. These products include standard apparatus, plain tubing in many intricate fabrications, crucibles, trays, cylindrical containers and piping in a full range of sizes up to 25" in diameter. Ingots and plates are available in general commercial quality as well as in special optical grades. Amersil engineers are also prepared to assist in developing fused quartz and silica equipment for special requirements.

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Platinum resistance spirals control equipment, measure temperatures with ±0.1°C accuracy. Available in many sizes, diameters, lengths, 25, 50, 100 ohm resistances.[a] Glass enclosed series for readings in −220°C to +500°C range.[b] Ceramic enclosed series for readings to 750°C, slightly less accurate than with glass, stability superior to thermocouples.[c] Laboratory standard resistance thermometer available for high precision readings. Available from stock or custom-fabricated. Send for literature.

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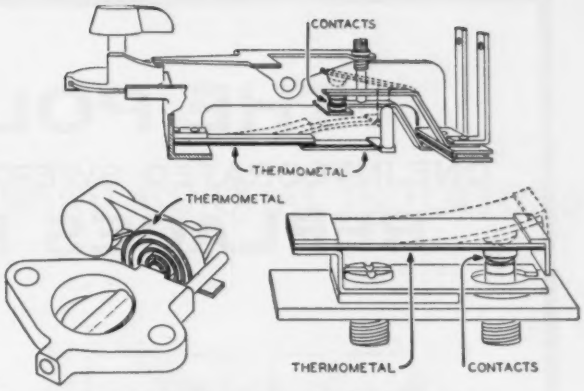

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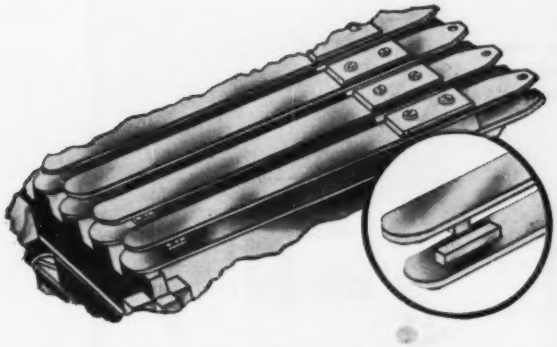

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High reliability welded contacts and contact assemblies available for your relays. Weld strength guaranteed. • Overall contact height held within ±.00025. Assemblies are available in gold, platinum, palladium, silver and their various alloys—both solid and laminated. Single contact usable for various contact ratings, for wet and dry circuitry—assemblies protected for shelf life and handling. Designs for attachment to header by welding or brazing. Complete electrical and mechanical design services available.

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☐ Econotape ☐ Deoxo Purifier–Puridryer

☐ Fused Quartz ☐ Platinum Spirals

☐ Nitroneal Generator

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ONE INTEGRATED SWEPT-FREQUENCY SYSTEM

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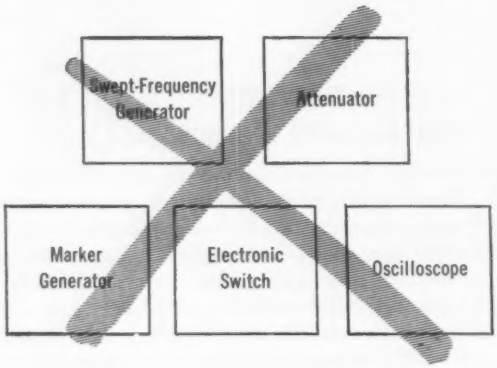

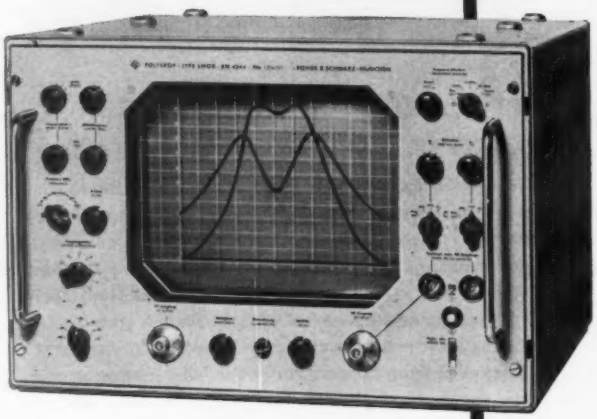

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TWO CHANNEL FREQUENCY RESPONSE DISPLAY FOR TWO AND FOUR TERMINAL NETWORK MEASUREMENTS.

The Polyskop Type SWOB is a visual display swept-frequency signal generator with a frequency range of 500 kc to 400 mc. It provides an automatic display of the response a given quantity exhibits with a change in frequency, thereby replacing time-consuming point-by-point measurements with display curves which render instantaneous answers. Measurement and alignment work may be relegated to semiskilled personnel, and production tests may easily be carried out by unskilled workers.

Outstanding Advantages of the POLYSKOP:

- Saves time — Solves problems up to 50 times faster.
- Saves money — Relieves skilled personnel from routine work.
- Universal usefulness — Wide frequency range (0.5 to 400 mc) covers radio and television upwards to UHF.
- Dual-trace display — Facilitates simultaneous checking of two mutually independent quantities.
- Completely self-contained measuring system — Control of error sources.
- Large screen scope display — Giving a resolution compatible with the accuracy which can be obtained with the system.
- Delivery from stock.

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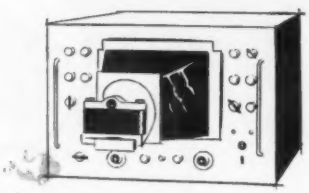
LESS THAN
ONE SECOND!



By employing a single lens Reflex 35 mm. camera in conjunction with the Polyskop, documentation is fast, simple and inexpensive. Resultant picture is a complete record, including graticule, frequency curves, serial number and date. Camera attachment is hinged for direct viewing.

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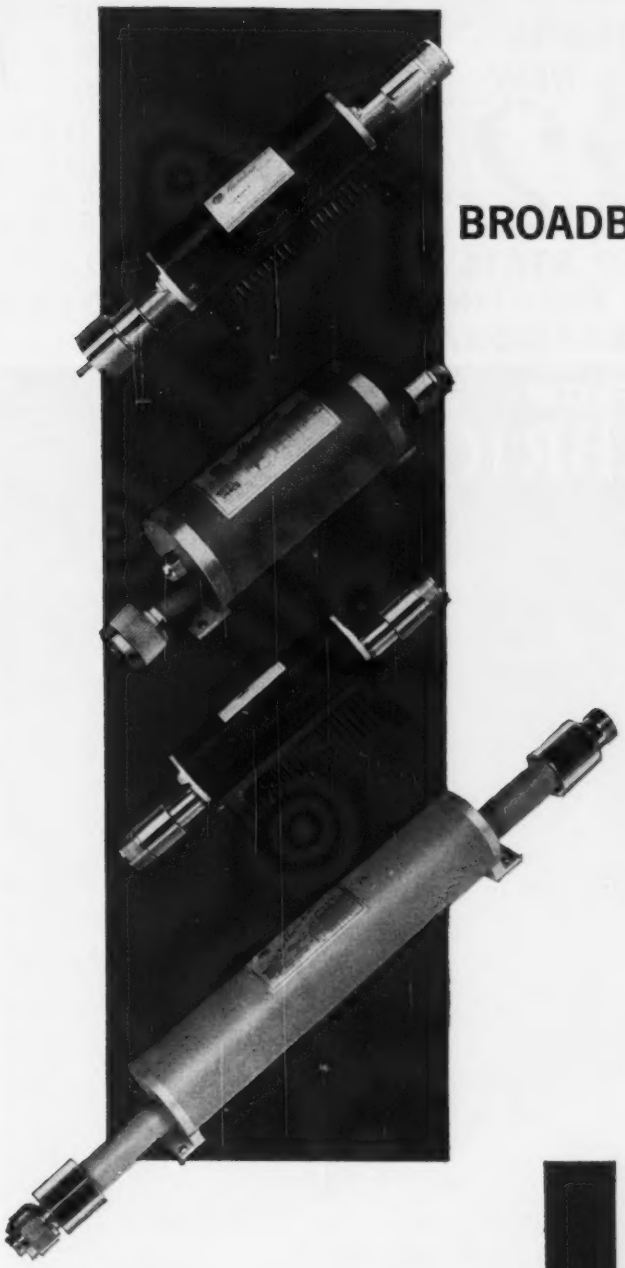

BROADBAND COAXIAL ISOLATORS

● Coaxial isolators, an original Sperry breakthrough, providing 10 to 1 isolation to insertion loss ratios, are available with octave bandwidth coverage at 200 w power levels, as well as low power general purpose units. Coaxial isolators with other extreme specification requirements are also available on special order.

As radar components, and for countermeasure and communication systems, and other applications requiring the utmost in performance, Sperry broadband coaxial isolators are playing and will continue to play an increasingly-important role.

Extensive ferrite research and development in a fully-equipped materials laboratory is a dominant factor in the high performance characteristics of the Sperry broadband coaxial ferrite isolators.

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We welcome your inquiries for more specific information.

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HIGH POWER BROADBAND FERRITE COAXIAL ISOLATORS

MODEL NUMBER	FREQUENCY KMC	AVERAGE POWER	MAX. db INS. LOSS	MIN. db ISOLATION
D44L2-7	.95-2.35	200W	1	10
D44L6	1.25-1.365	200W	1	10
D44S2	2.00-4.00	200W	1	10
D44S2-5	2.34-5.00	200W	1	10

LOW POWER BROADBAND FERRITE COAXIAL ISOLATORS

72L2	1-2	10W	1	10
72S2	2-4	10W	1	10
72C2	4-7	10W	1	10
72H2	7-11	10W	1	10
D44S5-1	2-4	10W	1.5	20

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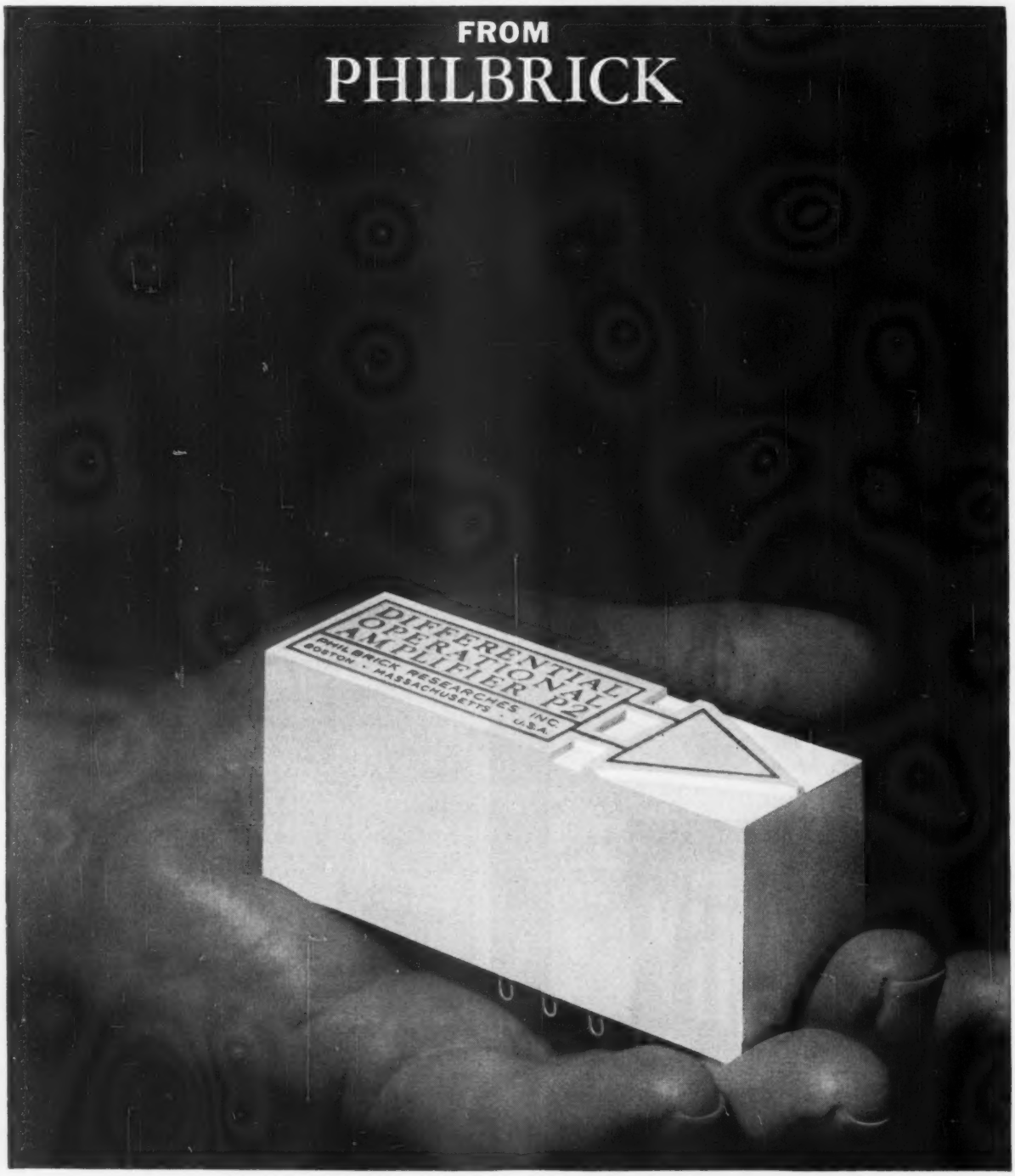
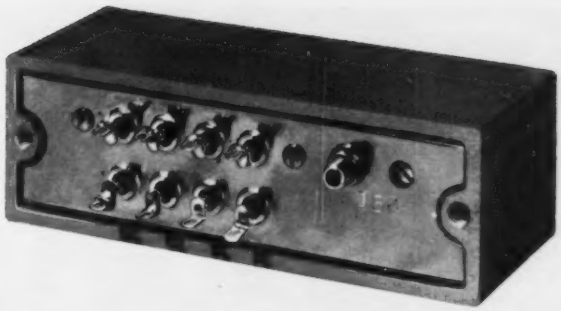


NO TUBES, NO CHOPPERS, NO COMMON MODE ERROR, VIRTUALLY NO INPUT CURRENT

(LESS THAN ONE TEN THOUSANDTH OF ONE MICROAMP)

AND ALMOST NO NOISE... NOTHING BUT PERFORMANCE



THE P2 IS UNIQUE — It is very likely that here — inside this rugged 4″ cast aluminum housing — is packed more performance and more versatility than you will find in any operational amplifier available in the world today.

A strong statement. One we're happy to back up with facts.

THESE ARE ITS FEATURES: Full differential input (truly floating with respect to ground). **Low input current** (typically less than 2×10^{-11} amp). **Low noise** (typically under 10 microvolts in the frequency range between DC and 1 KC). **Long term drift stability in sub-millivolt region. Coolness** (about 330 milliwatt dissipation). **Compactness** (4″ L x 1¼″ W x 1 11/16″ H; weight 11 oz.). **Economical operation** (no heater supply or tube replacement.) **Low price: $210**

HERE'S WHAT THE P2 CAN DO

The P2 is a dc amplifier with differential inputs, designed for analog computation and other instrument applications. These run all the way from high reliability process control to biological measurements. You can add, integrate, scale, and invert with it. Its differential inputs permit high impedance voltage following and amplification, subtraction, precise current driving to grounded loads, and many other esoteric and desirable operations.

Since inputs are electrically isolated from ground, there is no limit on the input common mode signal, except for the dielectric strength of the insulating materials. In addition, the P2's high input impedance and low input leakage accommodate the same resistors and capacitors normally used in vacuum tube circuitry: but with lower voltage ratings, greater compactness, and longer life.

Typical drift, when connected as a ten-second integrator using a one microfarad capacitor, is typically less than 100 microvolts per second.

The P2 requires 11 ma at plus and minus 15 volts from conventional supplies. Where portability is desired, it will operate continuously for about 75 hours in the field on just two pairs of small mercury batteries (TR-136 type).

SPECIFICATIONS

(Tentative)

ELECTRICAL

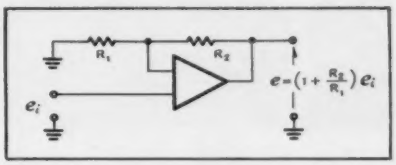
	Design	Q.C. pass limit
Gain:	30,000	20,000
Output range:	± 11V at 1.1 ma	± 10.0 volts at 1.0 ma
Minimum recommended load resistance:	10 KΩ. Will not be damaged by short circuit. Resistance loads below 10 KΩ tend to degrade the amplifier performance, but are feasible from the standpoint of safety.	
Input:		
Tolerable common mode signal level range:		± 200 volts
Admittance:	600 μμf	
Current: (at room temperature)	2×10^{-11} amp	10^{-10} amp
Drift: (referred to inputs) (20°-45°C.)	2 mv	5 mv
	typically less than 100μV in 8 hours at constant temperature	
Bandpass:	Small signal — unity open-loop gain at 75 kc	
	Large signal — output becomes amplitude limited at 1 kc	
	Output range will be reduced by 12 db/octave above 1 kc	
Power requirements:	± 15vdc at less than 11 ma (worst case load)	

MECHANICAL

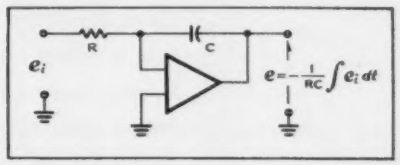
Dimensions:	4″ L x 1¼″ W x 1 11/16″ H plus 3/8″ additional clearance for terminals
Mounting:	3 11/16″ centers, 2 holes for No. 8 screws (furnished with unit)
Weight:	Mounted: 11 oz. Packed: 1 lb.
Enclosure:	Potted, cast aluminum case

For aid with your applications and for a demonstration of P2's capabilities, write, wire or phone Philbrick or your nearest Philbrick representative.

Ideal for computing instruments like these

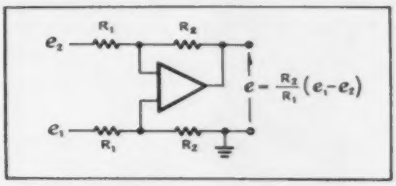


ELECTROMETER (ISOLATION) AMPLIFIER (non-inverting application): This circuit presents an extremely high dc input impedance to the source (actually higher than that of a K2-W amplifier by several decades). The gain ratio is determined by the feedback elements and is positive in polarity. Applications of this circuit include potentiometer unloading, peak-reading instrumentation, preamplification, and portable low-level electrometer-type measurements.



INTEGRATOR-MEMORY: P2's low input current and drift allow one to use high impedance values for R and C not usually considered feasible for transistor amplifiers. Considerable saving in the cost and bulk of polystyrene capacitors is inherent.

Example: R = 10 Megs and C = 1 μf gives a 10 second integration circuit.
Less than 30 millivolts error in the output is typical for a 5 minute period.



DIFFERENTIAL AMPLIFIER: The common mode rejection of this circuit is high indeed, being determined by the accuracy with which feedback ratios are maintained. Because of the input isolation, hundreds of volts of common mode signal are feasible without causing damage. The dc load on the source is almost entirely caused by the resistors alone. Using this circuit in conjunction with two pre-amplifiers of the type shown in Fig. 1, a precision differential electrometer is feasible.

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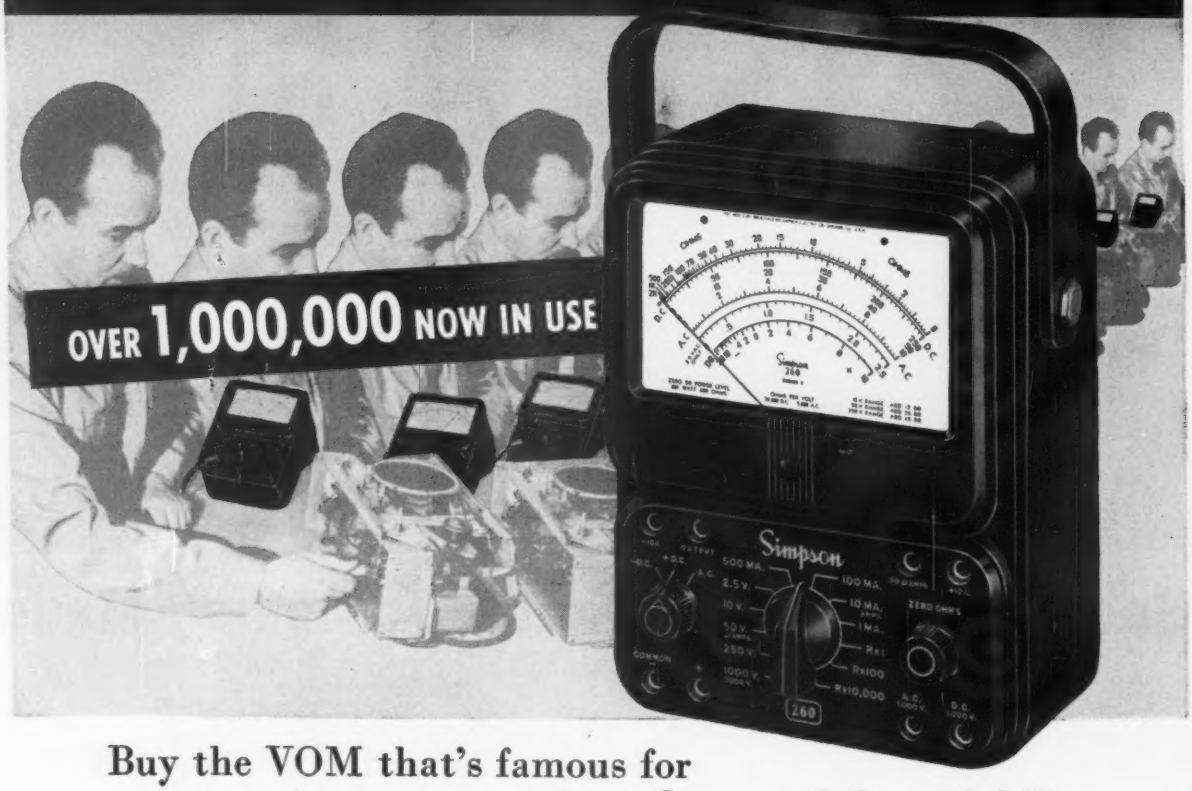

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A. F. Voltage (with 0.1 uf internal series capacitor): 0-2.5 v; 0-10 v; 0-50 v; 0-250 v.
Volume Level in Decibels (Zero DB equal to 1 milliwatt across a 600-ohm line): −20 to +10 DB; −8 to +22 DB; +6 to +36 DB; +20 to +50 DB.
D.C. Resistance: 0-2000 ohms (12 ohms center); 0-200,000 ohms (1200 ohms center); 0-20 megohms (120,000 ohms center).
Direct Current: 0-50 ua; 0-1 ma; 0-10 ma; 0-100 ma; 0-500 ma; 0-10 amp.

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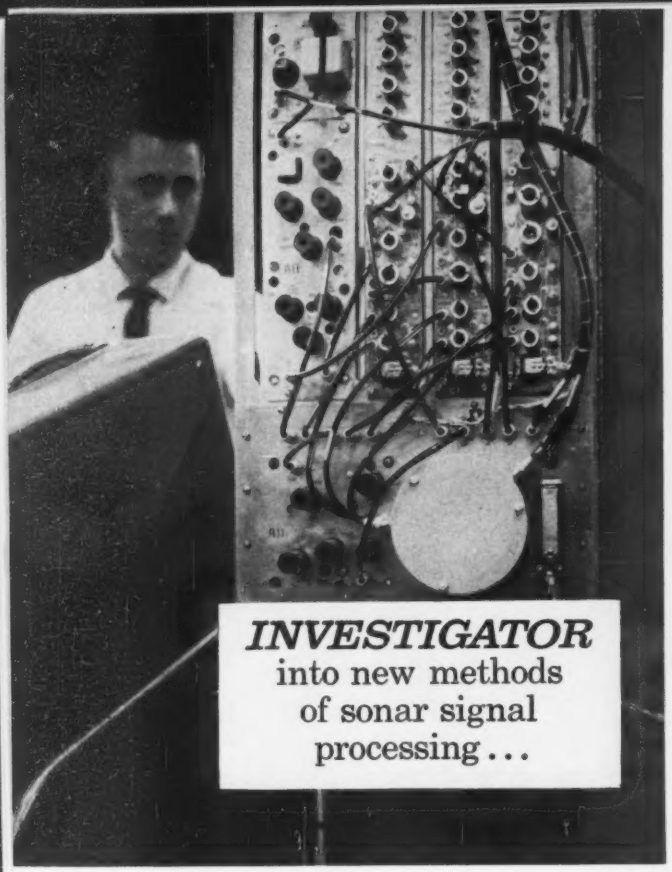

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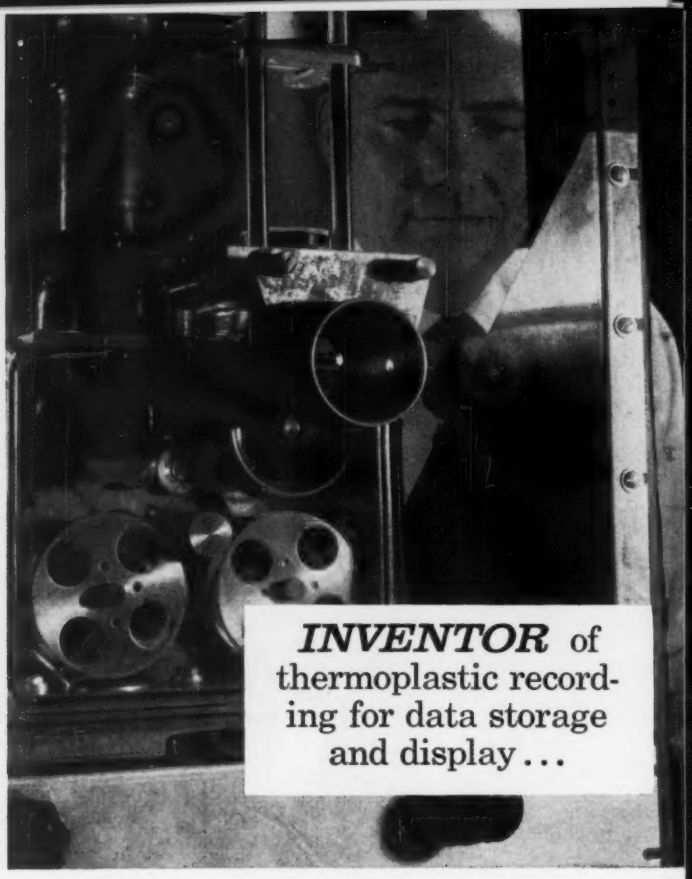

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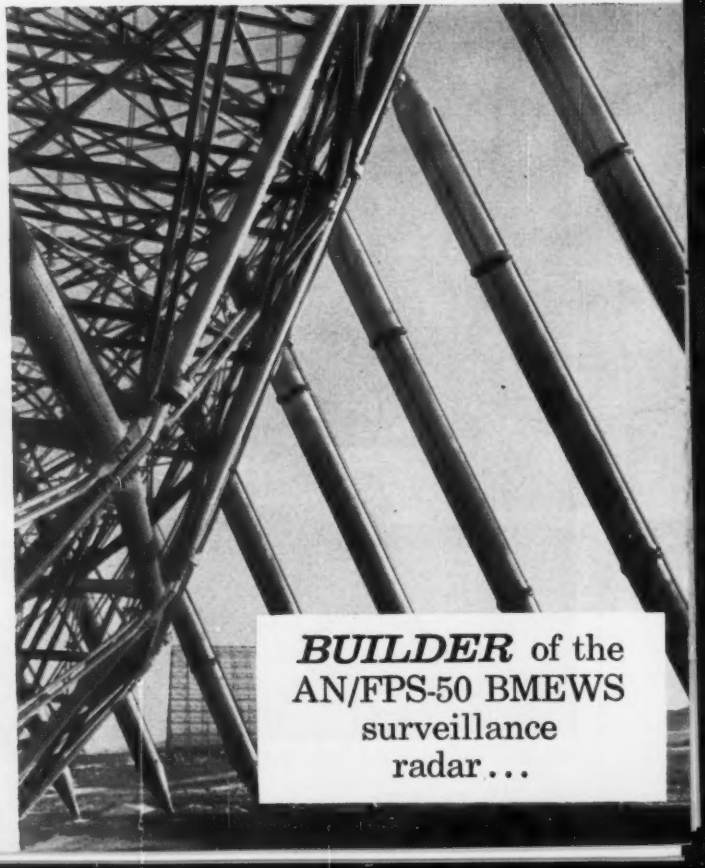
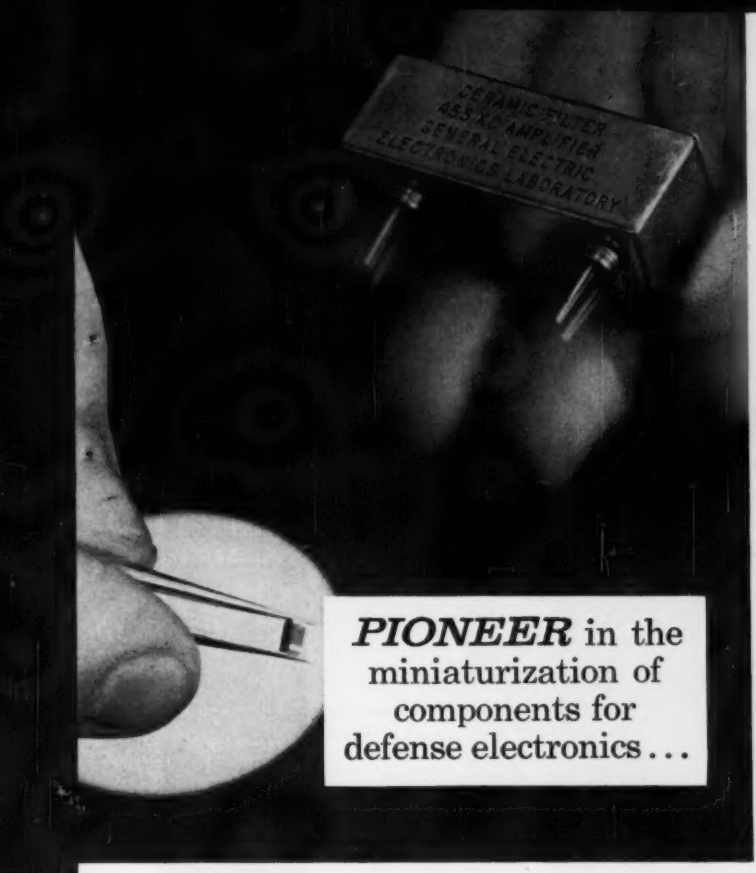
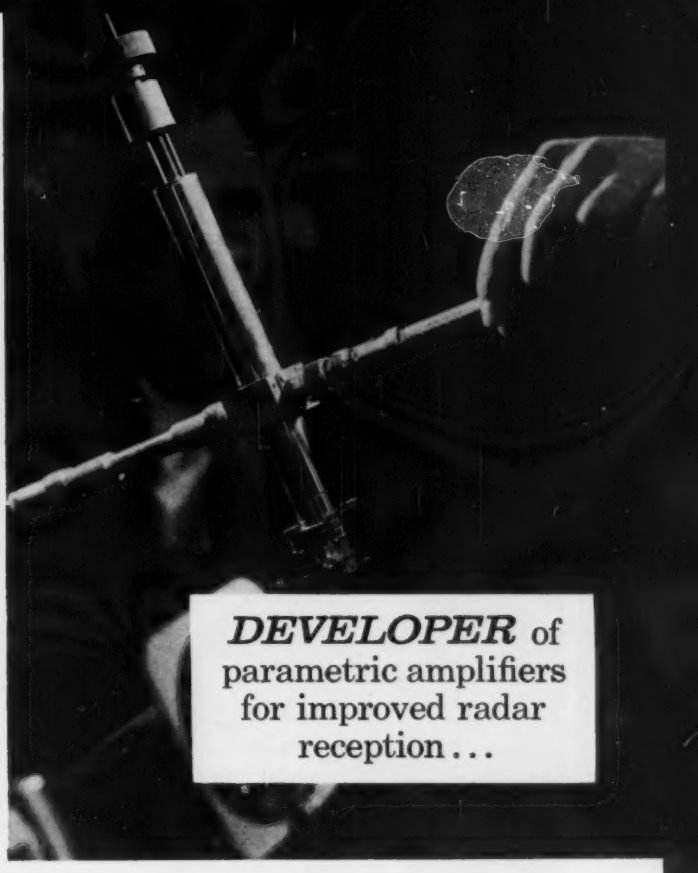
CONSTRUCTOR of the first fully automatic 3-D radar data processor...



BUILDER of the AN/FPS-50 BMEWS surveillance radar...

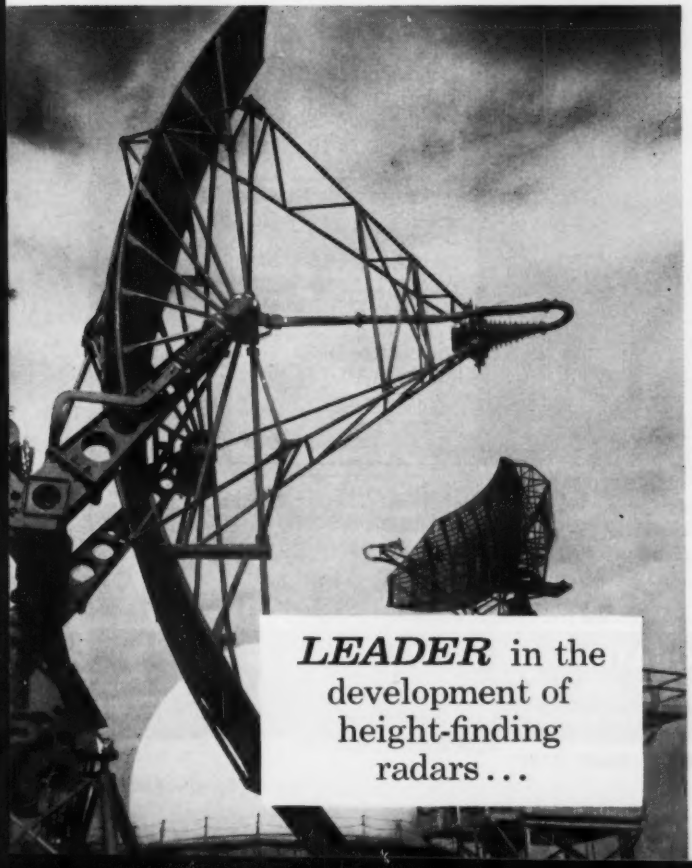


PIONEER in the miniaturization of components for defense electronics . . .



DEVELOPER of parametric amplifiers for improved radar reception . . .

Roles of HMED*



LEADER in the development of height-finding radars . . .

*General Electric's Heavy Military Electronics Department

Seven examples of the roles that General Electric's Heavy Military Electronics Department is playing in contributing to U.S. defense strength are illustrated here. Of course, the full spectrum of HMED activities is much broader. It includes work in radar, sonar, missile guidance and control, and computers; in data handling, communications, counter measures, and ground warfare; in air defense, missile defense, and product service. 176-10

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GENERAL ELECTRIC

DEFENSE ELECTRONICS DIVISION, SYRACUSE, N. Y.

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ALPHA electronic WIRE

MIL-W-16878C

MIL-W-16878C	DESCRIPTION (Single conductors)	VOLT RATING	CONDUCTOR SIZE	STOCK COLORS	ALPHA NUMBER
TYPE B UNCOVERED PLASTIC	stranded tinned copper, .010" vinyl thermoplastic insulation. 105°C	600	16-32	*1-19	1850-1858
TYPE B NYLON JACKET	stranded tinned copper, .010" vinyl thermoplastic insulation with clear nylon jacket overall. 115°C	600	16-32	*1-19	1860-1868
TYPE C UNCOVERED PLASTIC	stranded tinned copper, .016" vinyl thermoplastic insulation. 105°C	1000	14-24	Conductors 18-22 Colors *1-19 Conductors 14, 16, 24 Colors 1, 11-19	1830-1835
TYPE C NYLON JACKET	stranded tinned copper, .016" vinyl thermoplastic insulation with clear nylon jacket overall. 115°C	1000	14-24	Conductors 18-22 Colors *1-19 Conductors 14, 16, 24 Colors 1, 11-19	1840-1845
TYPE D UNCOVERED PLASTIC	stranded tinned copper, .032" vinyl thermoplastic insulation. 105°C	3000	6-24	Conductors 18-22 Colors *1-19 Conductors 6-16 & 24 Colors *1, 11-19	1870-1879
TYPE D NYLON JACKET	stranded tinned copper .032" vinyl thermoplastic insulation with clear nylon jacket overall. 115°C	3000	6-24	Conductors 18-24 Colors *1-19 Conductors 6-16 & 24 Colors *1, 11-19	1880-1889
TYPE E EXTRUDED & SPIRAL WRAPPED TEFLON WIRE	stranded silver plated copper, extruded or spiral wrapped Teflon insulation. .010" Wall. 200°C	600	14-30	Conductors 16-30 Colors *1-10 Conductor 14 Colors *1-6	Extruded 2851-2859 Wrapped 2881-2889

1. White
2. Black
3. Red
4. Green
5. Yellow
6. Lt. Blue
7. Brown
8. Orange
9. Gray (slate)
10. Violet (purple)
11. White/Black
12. White/Red
13. White/Green
14. White/Yellow
15. White/Blue
16. White/Brown
17. White/Orange
18. White/Gray
19. White/Violet

*Alpha can create for you over 40,000 military approved striped color combinations.

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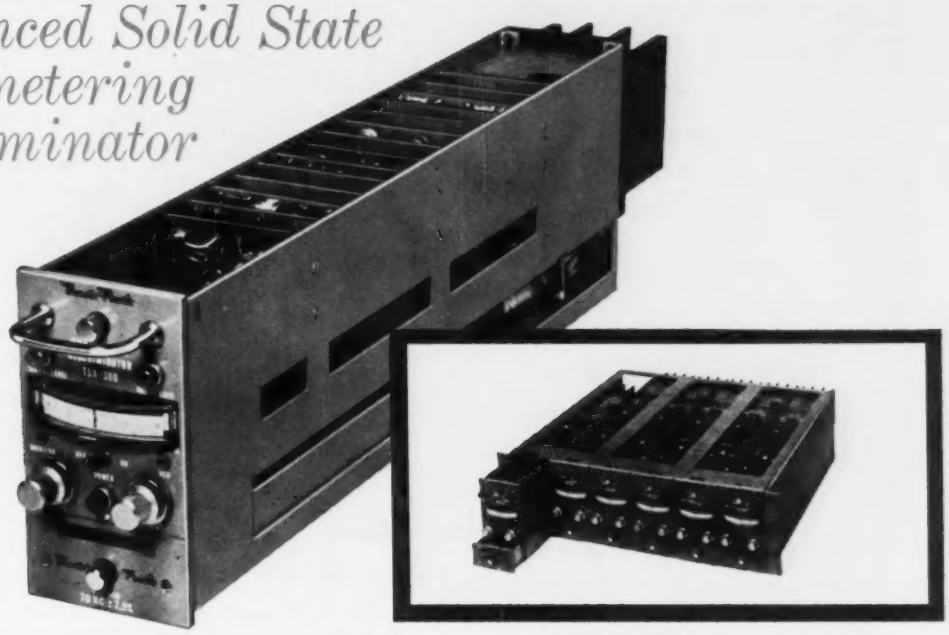
See Us at the I.R.E. — Booth 4103

NOW... from Bendix-Pacific

Advanced Solid State Telemetering Discriminator



In this TDA-300 Solid State Subcarrier Discriminator Bendix-Pacific has achieved a new standard of performance in an accurate and reliable data converter for use in FM/FM telemetry receiving stations and data reduction systems.

Smaller in size for comparable performance, completely accessible plug-in printed circuit modules and built-in power supply are characteristic features of its advanced design. Because of its minimum size and weight the Discriminator is particularly suited for use in aircraft and for installation in crowded mobile vehicles.

The Discriminator uses the phase lock loop concept of coherent detection to obtain maximum recovery of FM subcarrier signals. A mounting rack is available which permits mounting six discriminators in 5¼ inches panel height in a standard 19 inch rack. Provided on the front panel of the Discriminator are a horizontal panel meter, out-of-lock and low signal level lights, panel switch and adjustments for zero balance and voltage output.

DYNAMIC INPUT RANGE	10 millivolts to 10 volts rms (60 db) without input adjustment
FREQUENCIES AND BANDWIDTHS	MIL-T-26985 (IRIG) center frequencies and bandwidths are standard. Other center frequencies to 300 KC and bandwidths can be supplied
LINEARITY	Static linearity is within ±0.05% bandwidth of best straight line. Distortion of alternating inputs with modulation indices greater than 5 (dynamic linearity) is less than 1.0% bandwidth
POWER REQUIREMENT	Integral power supply operates from 105 to 125 volts rms at 40 to 420 cycles per second. Power consumption is less than 40 watts
SIZE	5¼ x 2 13/16 x 20 inches

Complete data and specifications are available on request.

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Bendix-Pacific Division

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  - POWER TRANSISTORS
- STATIC SWITCHING
- DC MOTOR CONTROL
- VARIABLE DC SUPPLIES
- DC TO DC CONVERTERS
- FREQUENCY CHANGERS
- INVERTERS
  - RELAYS
  - SWITCHES
  - CONTACTORS
  - CIRCUIT BREAKERS
- DYNAMIC BRAKING
- CONSTANT CURRENT SUPPLIES
- PULSE WIDTH MODULATION
- IGNITRON FIRING
- WELDING CONTROL
- TEMPERATURE CONTROL
- POWER PULSE GENERATOR
- AND MANY OTHERS

GENERAL ELECTRIC USN 2N681-688 SILICON CONTROLLED RECTIFIERS NOW MEET MIL-S-19500/108

The first SCR to meet MIL-S-19500/108 is now available in production quantities from General Electric. This is natural. G.E. originally developed the SCR, now offers a wide range of current ratings including the new C8, 1.3 amp and C55, 70 amp types. General Electric provides much of the know-how and ideas on how to apply the SCR . . . brought in reduced prices based on large volume production . . . and has reams of reliability and test data, the kind you should know about.

The G-E SCR is changing a lot of old ideas about power control and switching, in terms of circuit design *and* cost. Can you afford to wait any longer? Call your G-E Semiconductor District Sales Manager today. He'll give you all the help you need.

Rectifier Components Department, Section 25B8, General Electric Company, Auburn, New York. In Canada: Canadian General Electric, 189 Dufferin Street, Toronto, Ont. Export: International General Electric, 150 E. 42nd St., N. Y. 17, N. Y.

For fast delivery at factory-low prices see your local G-E Distributor.

GENERAL ELECTRIC

Accutron...*

new electronic timepiece uses ALLEN-BRADLEY Type TR Miniature Composition Resistors

A-B QUALITY

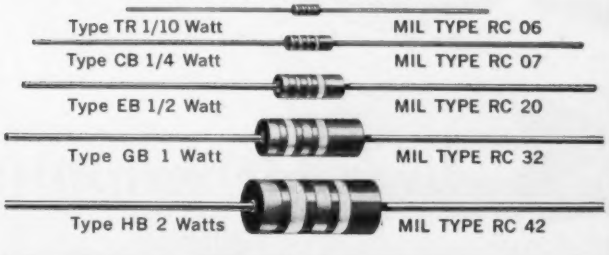
With its miniature tuning fork and electronic circuit, Accutron introduces an entirely new principle to timekeeping—one which promises unprecedented wrist timepiece accuracy. Strapped to your wrist, it is guaranteed not to gain or lose more than one minute a month.

Allen-Bradley Type TR tiny resistors enabled Accutron designers to achieve the required circuit miniaturization for a wrist timepiece—*without sacrificing reliability*. This circuit controls the 360 pulses of power each second—31 million per day—that drive the tuning fork. Although incredibly small, these Type TR miniature composition resistors are made by Allen-Bradley's exclusive hot molding process that *guarantees complete freedom from catastrophic failures!* A-B Type TR resistors are conservatively rated 1/10 watt at 70°C.

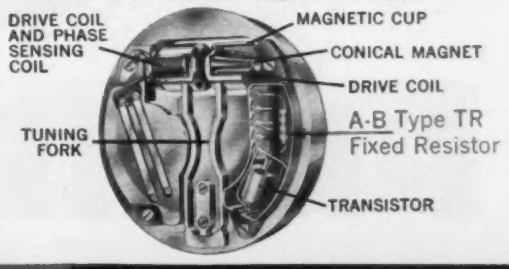
There are also other Allen-Bradley space-saving potentiometers, capacitors, and h-f filters that can help solve your miniaturization problem. And you obtain the same reliability for which the larger Allen-Bradley components have earned a world-wide reputation. For full details, send for Publication 6024.

* TRADEMARK BULOVA WATCH CO., INC.

A-B HOT MOLDED COMPOSITION RESISTORS

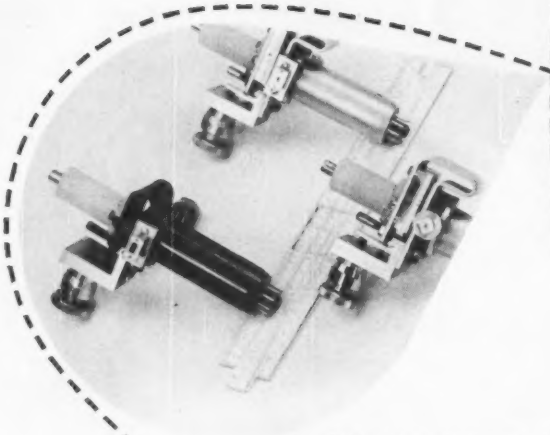

Type TR 1/10 Watt
MIL TYPE RC 06
Type CB 1/4 Watt
MIL TYPE RC 07
Type EB 1/2 Watt
MIL TYPE RC 20
Type GB 1 Watt
MIL TYPE RC 32
Type HB 2 Watts
MIL TYPE RC 42

DRAWING OF ACCUTRON SHOWS BASIC MECHANISM

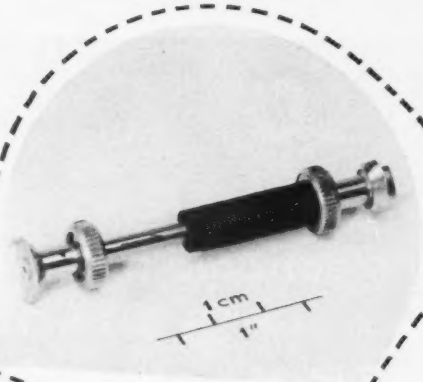


ALLEN-BRADLEY Quality Electronic Components

Allen-Bradley Co., 110 West Greenfield Avenue, Milwaukee 4, Wisconsin • In Canada: Allen-Bradley Canada Ltd., Galt, Ontario

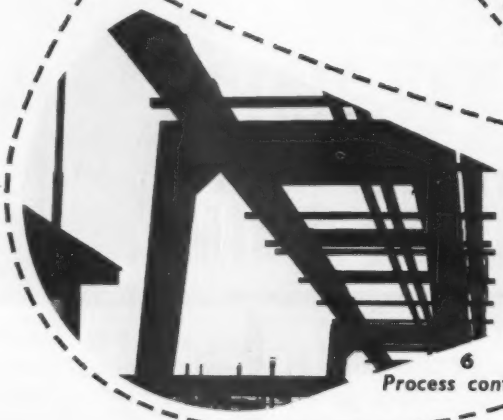


1 *Tube development*



2 *Solid state physics*

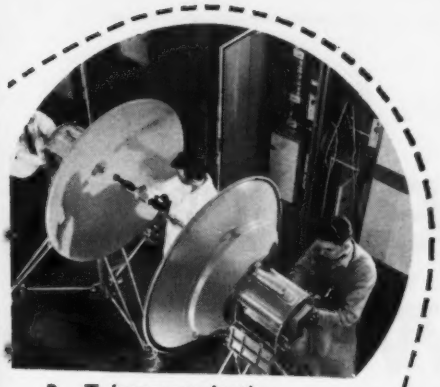
3 cm 8 mm
4 mm 2 mm
microwave equipment



6
Process control

PHILIPS *electronic measuring*

Detailed information on microwave components will be gladly supplied on request.
N.V. Philips' Gloeilampenfabrieken, EMA-Department, Eindhoven, the Netherlands
For Canada: Philips Electronics Ind. Ltd., 116 Vanderhoof Ave., Toronto 17, Ont.

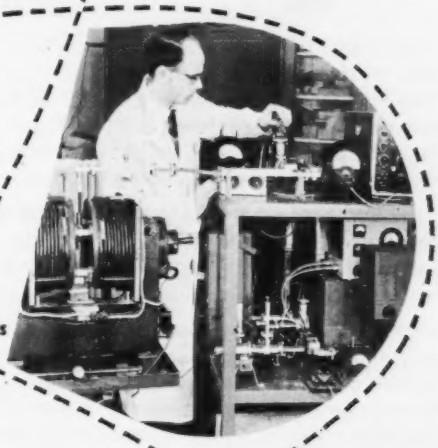


3 *Telecommunication*

SIX SOUND REASONS WHY

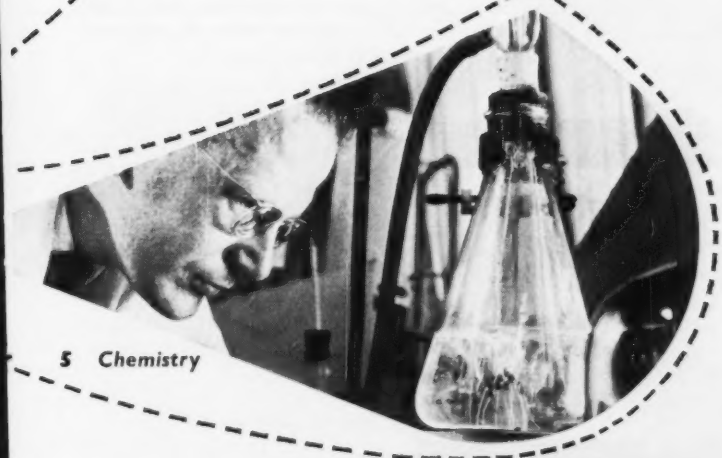
PHILIPS

are good at microwave equipment



4 *Physics*

The world-wide Philips industries are active in many branches of science and technology. Many of these are contributing to the development and application know-how of microwave equipment. The availability of information within the concern - as well as from outside sources - is logically leading to growing ranges of excellent components in the 3 cm, 8 mm, 4 mm and 2 mm bands.



5 *Chemistry*

1 ***Philips means electronics; klystrons and magnetrons are standard products . . . .***

2 ***Philips ferrites - well-known and hardly equalled - help to perfect microwave isolators . . . .***

3 ***Philips develop and manufacture radar and radio links, a closely allied technology . . . .***

4 ***Many applications are in the field of physical research. Philips Research Laboratories are amply equipped . . . .***

5 ***Application experience is also supplied by the many chemical specialists within the Philips organization . . . .***

6 ***Many impulses come from non-electronic quarters within, as well as outside the concern.***

instruments: quality ***tools*** for industry and research

PHILIPS

now 100 times greater average power

Now you can obtain traveling-wave tubes capable of 10 to 100 times the average power of conventional helix tubes. These X-band tubes are representative of a wide variety of the first commercially available all metal filter-type structures yielding both high gain and wide bandwidth. Their attractively small size and weight are made possible through application of the latest periodic focusing techniques.

Typical of these recent advances is the pictured 308H. For the first time a power traveling-wave tube is offered with a high-μ grid-controlled gun. This advantage, coupled with 53 db of saturation gain, provides exciting possibilities for the systems designer.

Consult with Hughes Microwave Tube Division if you have exacting design requirements of pulse rise time, phase shift sensitivity, bandwidth or power output. These qualities are yours in a light, compact, yet rugged package of all metal-ceramic construction. These advanced products can make your program a success. Orders are being accepted now for delivery in three or four months.

307H LEFT: 100 kw peak power output (500 watt average), 8.5—9.5 kmc frequency range, 54 db saturation gain, 1% maximum duty cycle, beam voltage = 38 kv, 21 lbs. total weight of tube and magnet.

308H

Control grid μ = 55. 15 kw peak power output (150 watt average), 8.6—9.9 kmc frequency range, 53 db saturation gain, 1% maximum duty cycle, beam voltage = 24 kv, 14 lbs. total weight of tube and magnet.

319H

20 kw peak power output (200 watt average), 8.4—9.6 kmc frequency range, 54 db saturation gain, 1% maximum duty cycle, beam voltage = 24 kv, 17 lbs. total weight of tube and magnet.

For full details on these and other equally outstanding tubes write or wire Hughes Microwave Tube Division, 11105 Anza Avenue, Los Angeles 45, California.

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HUGHES

MICROWAVE TUBE DIVISION
HUGHES AIRCRAFT COMPANY

PRD *previews/reviews/design notes*

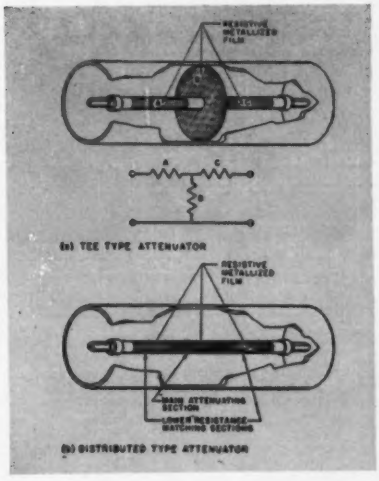
Design Considerations of Attenuators

The end use of an attenuator—whether as a standard in power or attenuation measurements, a power or signal level adjuster, an isolator or buffer pad—will, of course, bear on its design. But certain design and construction needs also remain constant. Here are some of the considerations that go into a PRD attenuator.

Attenuating Elements

We have found that metallized glass or ceramic generally make the best resistive elements. They are smooth, chemically inert, non-hygroscopic, and will not warp or change shape. We apply an extremely thin metal film to the element in two ways: by "paint" coating and baking, and by high vacuum deposition. The baked-on film method proves best for coaxial attenuators, and the vacuum deposition preferable for waveguide.

Fixed Coaxial Attenuators

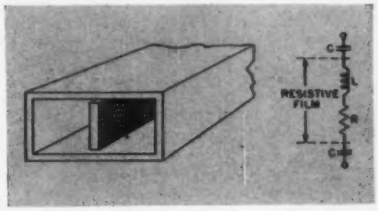


PRD 1100

PRD 130

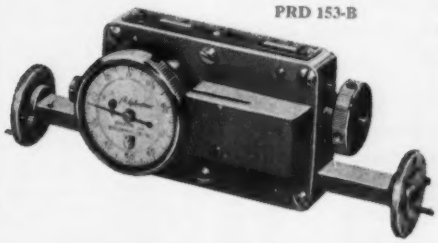
The two basic types of coaxial attenuators produced by PRD are shown above, in schematic drawing and photographs. The first, represented by the PRD 1100, uses one or more T sections with lumped resistive elements. The distributed type, illustrated by the PRD 130, uses an inner conductor of an electrically long resistive film. The T section PRD 1100 operates best at low frequencies, from dc to 4 KMC; the PRD 130 ranges from 2 to 10 KMC. Both dissipate one watt and are calibrated to ±0.2 db accuracy. The PRD 130 can attenuate up to 20 db; PRD 1100 up to 10 db.

Waveguide Attenuators

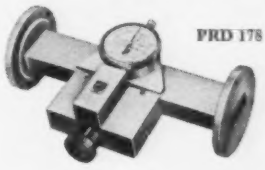


The drawing above gives a schematic presentation, with equivalent circuit, of a resistive film parallel to the electric lines in a waveguide. Attenuation is varied by moving the metal-coated glass panel in two usual ways: (1) by lowering it into the waveguide through a slot, as in the PRD 153-B, known as a "flap" type (Freq. range 18.0 to 26.5 KMC; Attenuation to 35 db; Max. VSWR 1.10; Max. insertion loss 0.5 db; Calibration accuracy ±0.2); or (2) by moving the lossy element from the side wall toward the center of the waveguide

PRD 153-B



...known as the "vane" technique, and illustrated by PRD 178-B (Freq. range 5.4 to 7.2 KMC; Attenuation to 45 db; Max. VSWR 1.15; Max. insertion loss 0.5 db; Accuracy to ± 0.2).


PRD 178

Another version of the vane method of attenuation is exemplified by our level set attenuators, such as the PRD 171-B (Freq. range 2.6 to 3.95 KMC; Max. attenuation to 40 db; Max. VSWR 1.15).

PRD 171-B

These are only a few of more than one hundred attenuators produced by PRD and a brief review of the broad design principles involved. For more specifications on these and other units, write for the PRD Attenuator brochure. For design information, write our Applications Engineering Department.

We have many interesting openings for engineers...contact Mr. John R. Zabka

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For prices and complete specifications on POWER SOURCES high and low voltage solid state power supplies, write, wire or phone today.

High Voltage Supply Specifications

	PS4222	PS4230	PS4232
DC Output Range	35-215 volts 0-1.5 amps	90-300 volts 0-1.5 amps	115-325 volts 0-1.5 amps
AC Input	105-125 volts, 50-60 cps*, all models		
Regulation (line)	Better than 0.1% or 0.2 volts over entire input range (whichever is greater)		
Regulation (load)	Better than 0.1% or 0.2 volts for no-load to full load (whichever is greater)		
Transient Response	Output remains within regulation limits for step-function change of ±10 volts in 105-125 volt input range Output remains within regulation limits for changes from no-load to full-load or full-load to no-load		

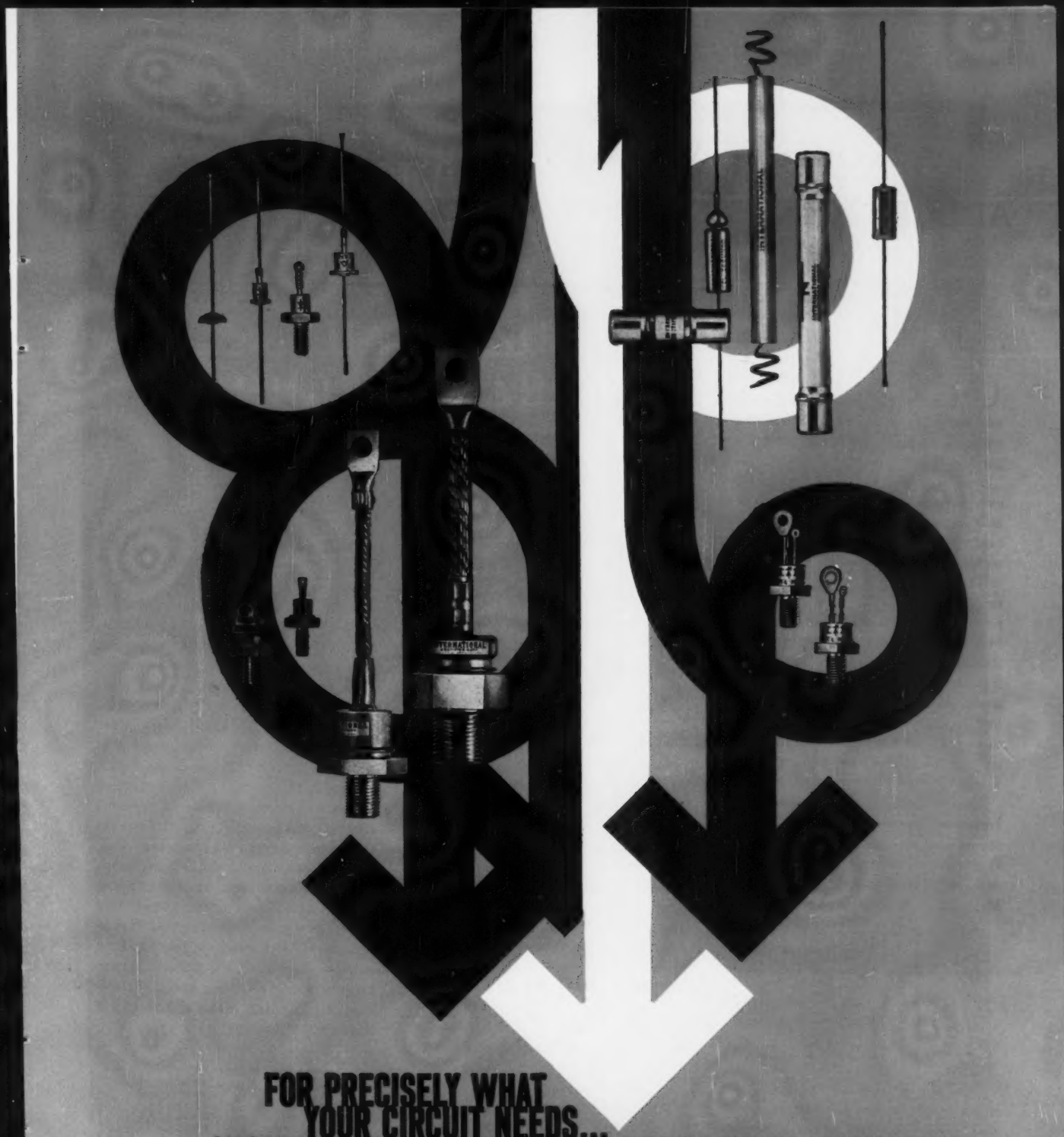
Low Voltage Supply Specifications

	PS4305	PS4315	PS4330
DC Output Range	0-36 volts 0-5 amps	0-36 volts 0-15 amps	0-36 volts 0-30 amps
AC Input	105-125 volts, 50-60 cps*, all models		
Regulation (line)	Better than 0.025% or 3 mv over input range (whichever is greater)		
Regulation (load)	Better than 0.05% or 5 mv, no-load to full-load variation (whichever is greater)		
Transient Response	Output remains within regulation limits for line voltage steps of ±10 volts within input range Output recovers in 100 usec for no-load to full-load or full-load to 50% load step changes.		

*400 cps available on order

Specify POWER SOURCES BY

POWER SOURCES, INC. Burlington, Massachusetts



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CIRCLE 79 ON READER SERVICE CARD

Advertisement

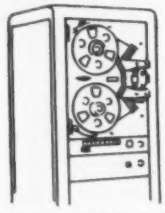
A WORD OF WARNING ABOUT THE NEW ALLUREMENTS OF RECOMP II [and a modest word about price]

Could you be enticed by a computer? Surprisingly, there *are* businessmen and scientists who have allowed their emotions to get quite out of control regarding Recomp II.

And now there is more reason than ever for becoming enamored with this amazing computer. *Three* reasons, to be exact, and all of them new. Hence, our warning to you.

The first reason is, in itself, enough to steal your heart away: it is Recomp II's new reduced lease price. Always the darling of the medium-scale computer user, Recomp II has been so well accepted that it can now be offered at significantly lower terms. And it *still* provides the identical quality, solid-state performance, and features that can't be found on computers costing three times what Recomp II *used* to cost.

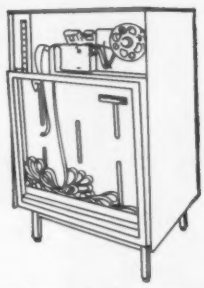
This is heady stuff—but even more enticements lie in wait. You can now add an optional modification to your Recomp II to enlarge its capacity by using magnetic tape. Here you see the new Recomp Magnetic Tape Transport unit.



Naturally it's superbly designed, solid state throughout. But don't let its quietly well-bred air fool you; it has a memory that would stagger an elephant—over 600,000 words. And up to eight of the Transport units can be connected to Recomp II, giving you a computer with a total memory capacity of over 5,000,000 words. Steady there, Mr. Simpson!

The speed of this new magnetic tape control is something to applaud, too: read and write speed is 1850 characters a second; bidirectional search speed is 55 inches per second. Do you begin to see why we warned you about these new allurements of Recomp?

Below you see another new optional feature for your Recomp II: the Facitape tape punch and reader console. It punches 150 characters a second, reads 600 characters a second, and stops on a character. It adjusts to read and punch from 5



through 8 channels. It is versatile, accurate, fast, simple-to-operate, economical, reliable. And it has perfect manners: the mechanical components are completely enclosed in a soundproof housing.

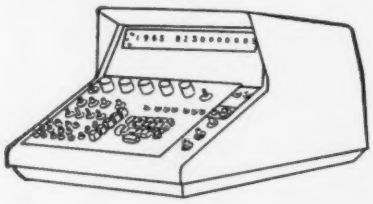
But lest we harp too much on the *new* features of Recomp II, perhaps we had better remind you of some of the extraordinary features that Recomp II *already had*. Features that have always made it the finest computer in the low-priced field.

1] Recomp II is the *only* compact computer with built-in floating point arithmetic. It defies being hemmed in on a problem. With its large capacity it obviates computer-claustrophobia.

2] Recomp II was the first solid-state computer on the market. As you can see by the new features above, Recomp II's scrupulous engineers have seen to it that it remains the *finest* solid-state computer on the market.

3] Recomp II seems to have more built-in features than a dream home kitchen. It has built-in square root command. Built-in automatic conversion from decimal to binary.

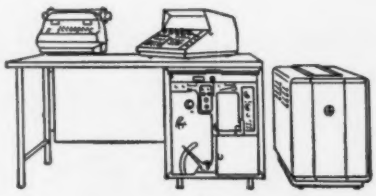
Here you see Recomp II's distinctive keyboard. It looks easy enough to operate—and it *is!* And because Recomp II



requires no specialized talents, anyone with computer problems can be taught to use it.

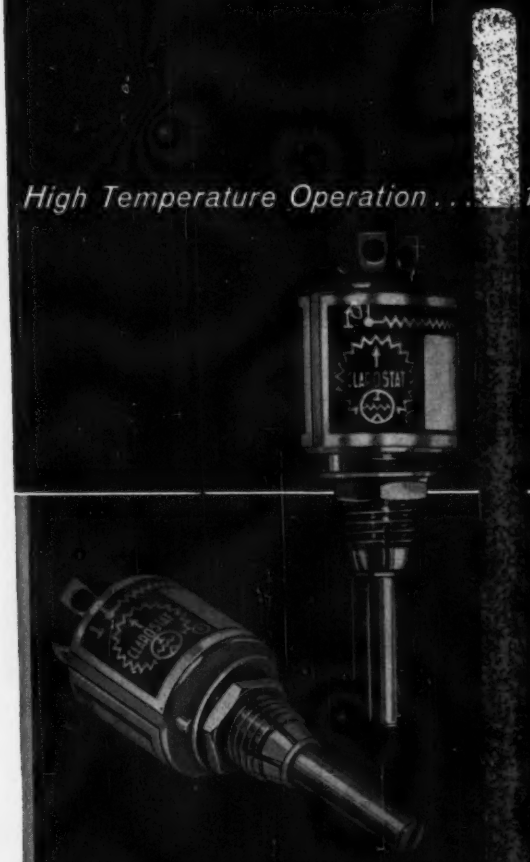
One look at Recomp II leaves little wonder that even practical people have allowed their hearts to influence them in choosing Recomp II. Without being showy, it is an object of beauty that reflects its supreme precision of performance. Its distinguished exterior bespeaks the ultimate of excellence; *c'est sans pareil.*

But if you want to avoid being captivated by a computer you should know how strong your emotions will run. May we suggest a *test?* Expose yourself to Recomp II. See it in action. Touch it. Feed problems into it. This is the only way to know how you will react to this extraordinary computer. Make a date to see Recomp II right away.



Write AUTONETICS INDUSTRIAL PRODUCTS, Dept. 025, 3400 E. 70th St., Long Beach, Calif.
The Autonetics Division of North American Aviation, Inc.

SERIES 57EM HALF-INCH HIGH RELIABILITY POTENTIOMETERS



High Temperature Operation . . . 150° C

Here's performance to match those "beyond the usual" requirements in a compact, quality potentiometer. The Clarostat Series 57EM is now available with glass-sealed terminals to meet 150° C operating conditions.

Available in all common shaft configurations including set-and-forget types for trimming applications with split locking bushings.

These units are manufactured in accordance with the applicable sections of MIL-R-19, MIL-R-12934 and MIL-R-27208.

SPECIFICATIONS — SERIES 57EM WIRE-WOUND POTENTIOMETERS

• Diameter	1/2"
• Body Length	33/64"
• Maximum Resistance	100,000 ohms
• Linearity	2%
• Wattage	2.0
• Weight	.25 ozs

WRITE FOR COMPLETE INFORMATION

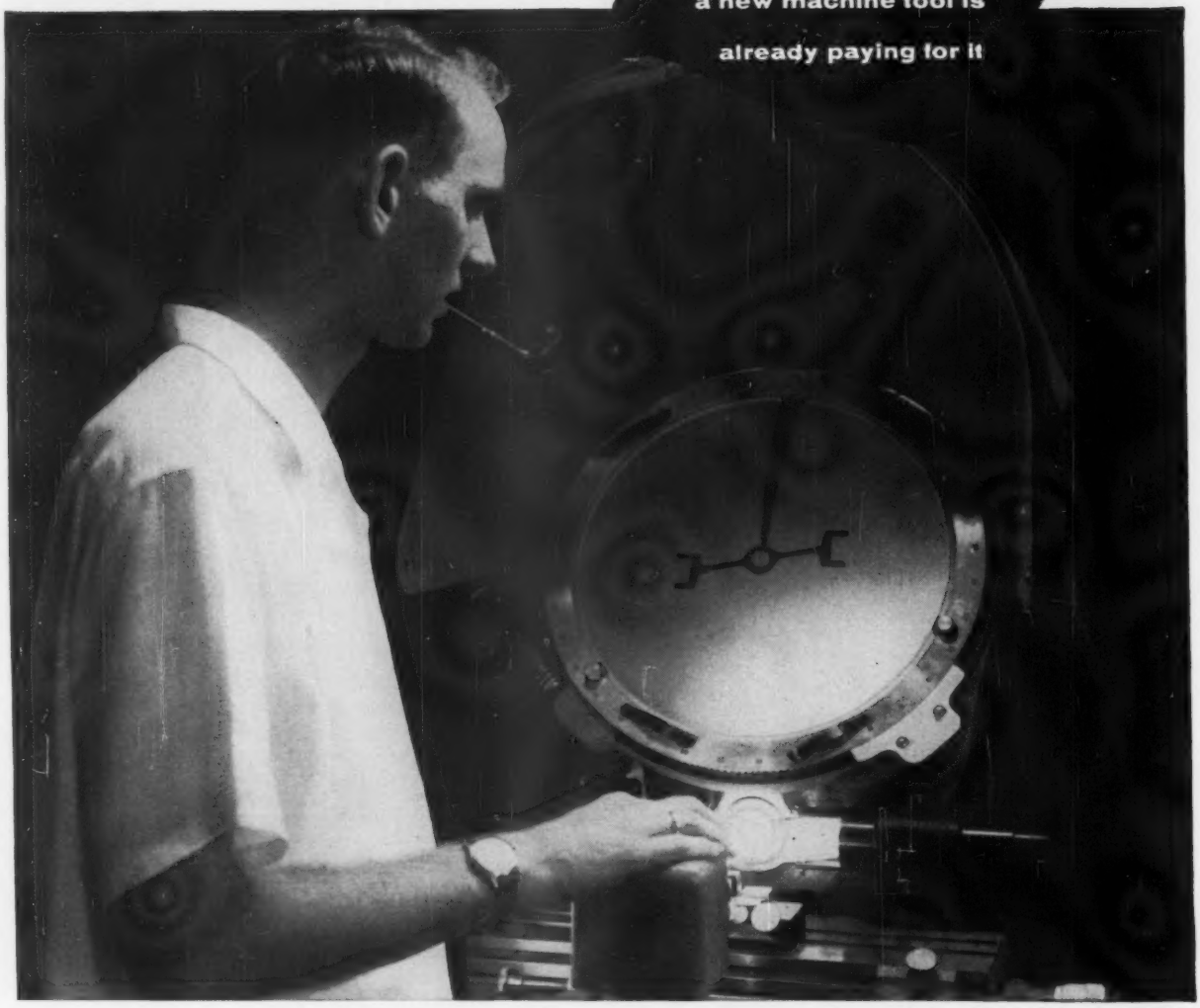
Compare

CLAROSTAT

CLAROSTAT MANUFACTURING CO., INC.
DOVER, NEW HAMPSHIRE

JONES & LAMSON
OPTICAL COMPARATORS

the man who needs
a new machine tool is
already paying for it



This Comparator Paid for itself in less than a week!

At Ace Electronics Associates, Inc., Somerville, Mass., an alert management cut costs, increased production and improved product quality through speedy, precise inspection methods using a J & L Optical Comparator.

At Ace, precision of manufacture is of paramount importance. This young, progressive company, manufacturer of linear and non-linear potentiometers and electromechanical devices, including Acepot and Acetrim, insists that each and every product made in its plant give 100% reliability in the field. The aim is to not only meet, but to surpass its customers' most exacting specifications. This is being done consistently on every piece, every day.

Through stringent quality control procedures tailored to meet unique tolerance problems, manufacturing methods have been constantly improved, costs have been cut to the bone, production has reached new high levels, and product reliability is superb.

Ace gives much of the credit for this record to the Jones & Lamson Optical Comparator, which is their most important measuring and inspecting tool.

Write for new Comparator literature. Jones & Lamson Machine Company, 539 Clinton Street, Springfield, Vermont.

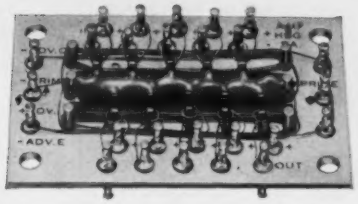
Turret Lathes • Automatic Lathes • Tape Controlled Machines • Thread & Form Grinders • Optical Comparators • Thread Tools

COUNTS LIKE MAD!

Miniaturization . . . extreme reliability . . . almost negligible power consumption . . . low bit cost—these merely provide the base for a whole stack of advantages when you choose AMP-MAD® Counters over other types.

AMP-MAD Counters are made with special multiaperture magnetic cores and wire **only.** Cores and wiring can be totally encapsulated. AMP-MAD devices provide either static count indication, or, in the case of higher count rates, a dynamic output as the count changes.

Identical counter/driver units are triggered by pulses to be counted. As shown (below), in cascaded decade applications, units and tens "carry" kicks over following decade counter/driver and advances the count . . . with no limit to the number of decades!

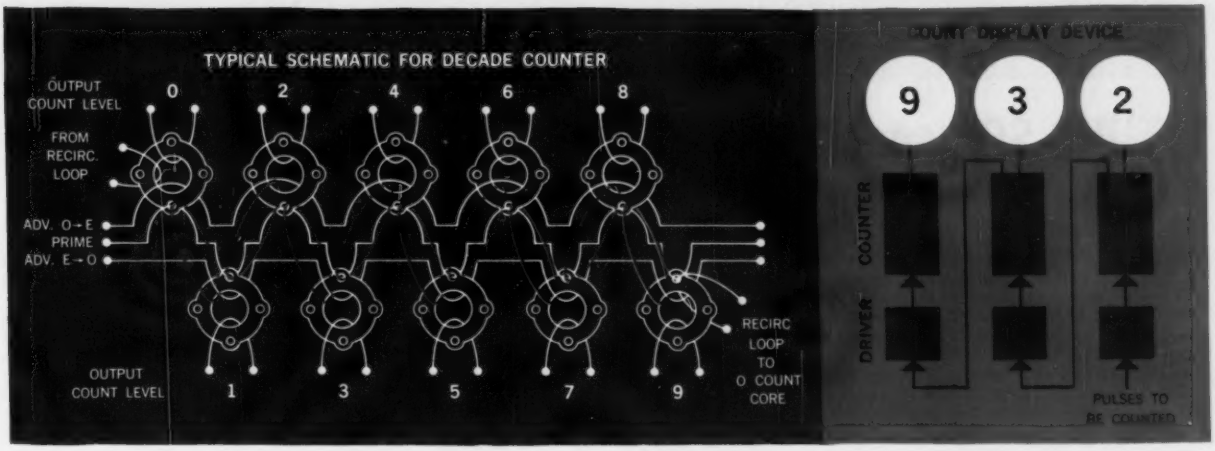


(Actual length 1 27/32" max.)

Check these additional AMP-MAD features:

- −55°C to +75°C temperature operating range (standard)
- small size—fits miniaturization requirements
- ultimate in reliability
- requires no sustaining power
- one to zero discrimination of 8 to 1 (20 to 1 on request)
- non-volatile count storage
- minor aperture output level up to 80 mw for incandescent light display of count (alternate output wiring scheme for that illustrated).

You'll want to know more about AMP-MAD Counters . . . Shift Registers, too! And there's more to tell. Write for complete information today.

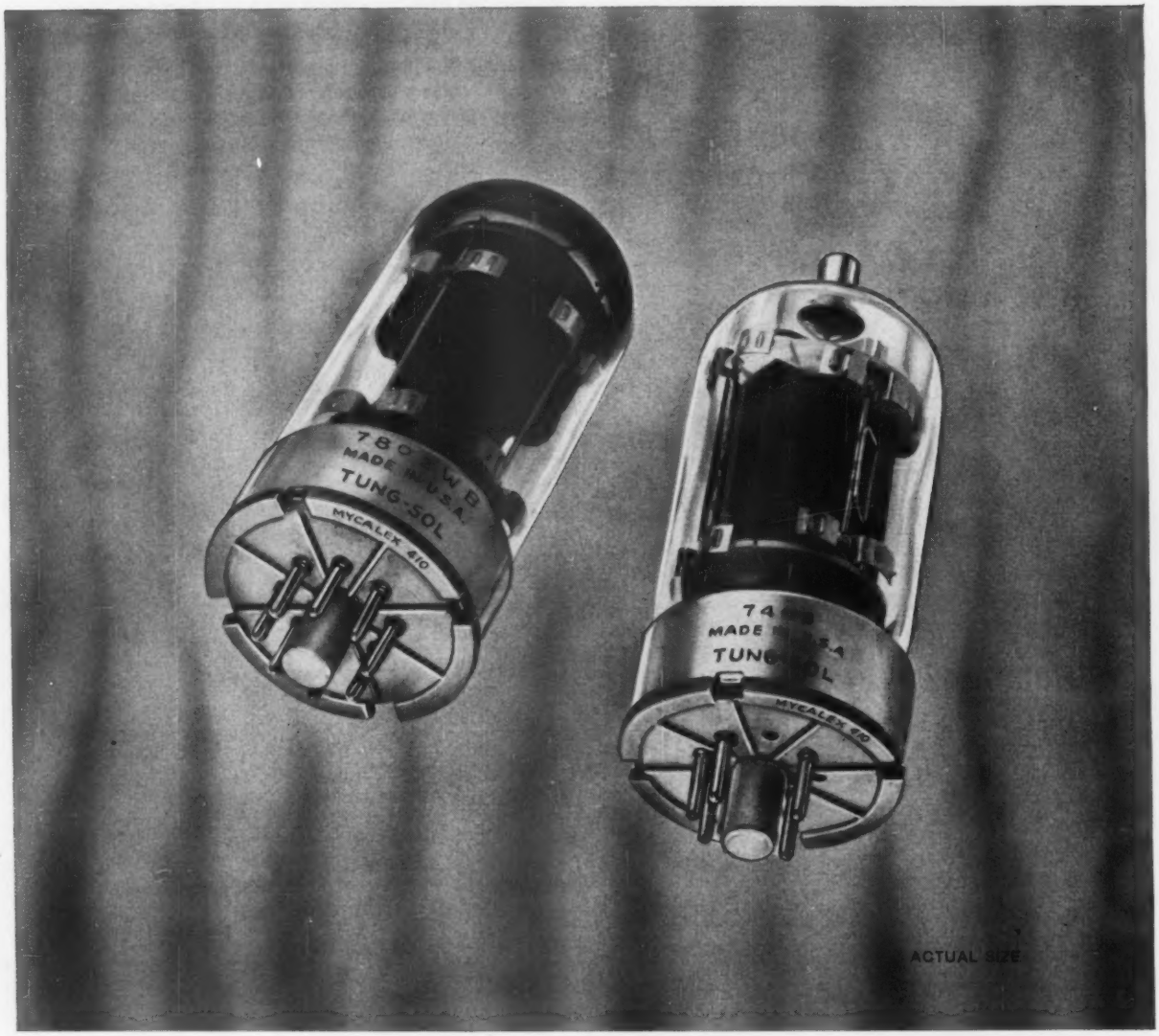


AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

When the requirements seem impossible...



TUNG-SOL specifies MYCALEX® 410 glass-bonded mica for extraordinary reliability

THE HEAT'S ON . . . to combat close quarters in critical power supply applications resulting in bulb temperatures up to 572°F., TUNG-SOL engineers chose MYCALEX 410 glass-bonded mica for the base of their new 7802WB Series Regulator Tube. TUNG-SOL also specifies the MYCALEX 410 glass-bonded mica for its new type 7403 "hard" pulse modulator tube. This *unique* electronic insulating material . . . can be precision-molded . . . does not blister, char or develop leakage paths under difficult operating conditions. It exceeds requirements for a MIL-E-ID Qualification Zone 15 rating . . . offering a maximum temperature endurance of 650°F. (unstressed), and absolute dimensional stability.

Whatever your problem—"hot spots," reliability, intricate inserts, complex geometry—MYCALEX CORPORATION OF AMERICA has the facilities to supply a ceramoplastic or glass-bonded mica insulation material in either precision-molded or machinable grades for your application. On short or large production runs, the more exacting the specification, the more you will appreciate the unduplicated advantages of these materials. Write for design information on MYCALEX glass-bonded mica . . . SUPRAMICA® ceramoplastics offering maximum temperature endurance of 1550°F. (unstressed) and SYNTHAMICA® synthetic mica with maximum temperature endurance of 2000°F. (unstressed) . . . the family of the world's most *nearly perfect* insulation materials.

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World's largest manufacturer of ceramoplastics, glass-bonded mica and synthetic mica products

EMC MOLDED POT ENDS CASTING WASTE!

Here's how Clarostat nearly tripled output per worker and cut reject rates with American-Marietta's new Epoxy Molding Compound

HANDLING EASE of dry, one component EMC is a major reason why Clarostat, Dover, New Hampshire potentiometer manufacturers abandoned awkward liquid epoxy casting methods. Molding with EMC allows mixing of large batch quantities and eliminates the waste of mixing small batches of liquid material.

VOLUME MOLDING with EMC sharply increased unit production with less than half as many operators. Since switching to EMC molding, individual operators now are able to produce nearly 300% more potentiometers per day! Because one component EMC allows no possibility of mixing inconsistencies, far fewer pots are rejected for flaws in finish or uniformity.

IMPROVED PRODUCT PERFORMANCE and reliability of their Series 53 M Control is a direct benefit of the uniformity of versatile EMC. Consistently meeting tightest design specs, EMC molding helps Clarostat engineers assure top performance and workmanship in their critically designed control.

WRITE TODAY FOR DETAILED INFORMATION

American-Marietta Company
3400 13th Avenue S. W.
Seattle 4, Washington

Please rush complete EMC data and molding information to:

Name_____

Title_____

Firm_____

Address_____

City_____ Zone_____ State_____

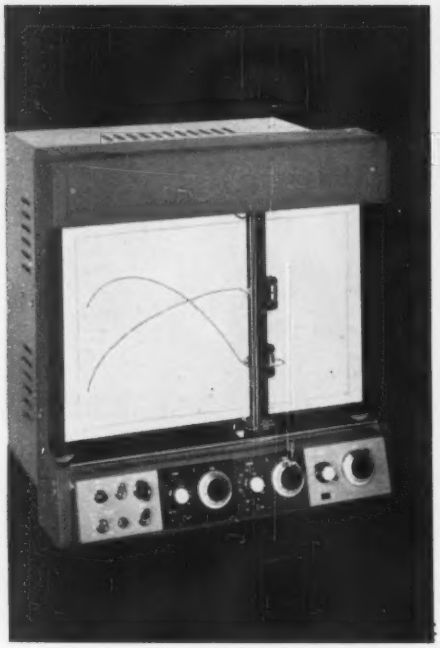
AMERICAN-MARIETTA COMPANY

Adhesive, Resin & Chemical Division
Seattle, Washington
Newark, Ohio

AUTOGRAF AUTOGRAF AUTOGRAF

Moseley 4B AUTOGRAF Recorder

PLOTS TWO DEPENDENT VARIABLES AGAINST SINGLE INDEPENDENT VARIABLE



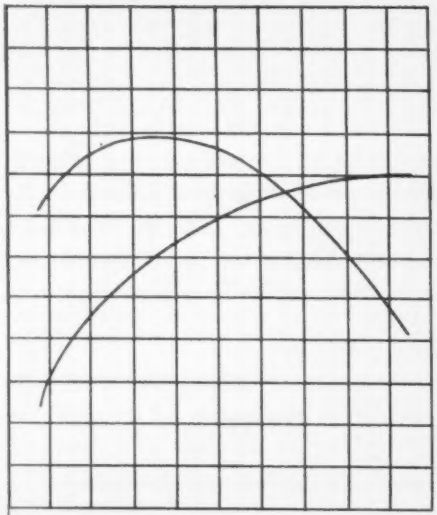
The MOSELEY Model 4B Recorder simultaneously plots two dc input signals against a third signal in cartesian coordinates on standard graph paper.

An internal X-axis time base permits plotting two variables against time.

Three pens are employed; one a fixed pen serving as an event marker to identify significant points during recording. Plotting pens are controlled by independent servos; electrically isolated separate amplifiers eliminate interaction and filters smooth noisy signals for a superior plot.

Model 4B employs either 11" x 17" or 8½" x 11" paper with continuous vacuum hold-down. Transfer switches on range controls permit arbitrary fitting of the voltage to any part of the chart.

The instrument is rack mounted with a vertical recording surface, tilted front control panel, and input connections at the rear.



SPECIFICATIONS

Recording Mechanism:	Independent servo drives for X_1, Y_1, Y_2 axes; free of ground.
Paper Size:	8½" x 11", 11" x 17", vacuum hold.
Recording Speed:	1½" sec on X axis, ½" sec on Y axis for full scale travel.
Input Voltage Ranges:	X axis: 10 ranges, 7.5 mv to 150 v Y axis: 10 ranges, 5 mv to 100 v
Time Intervals:	5 ranges, 7.5 to 750 sec full scale travel (X axis)
Input Resistance:	200,000 ohms/v up to 2 v range; 2 megohms on higher ranges.
Accuracy:	Better than 0.2% full scale. Resetability better than 0.1% full scale.
Power:	115 v, 60 cps, 100 watts. (Other voltages and frequencies to order)
Price:	$3,450.00 f.o.b. factory.

Data and price subject to change without notice.

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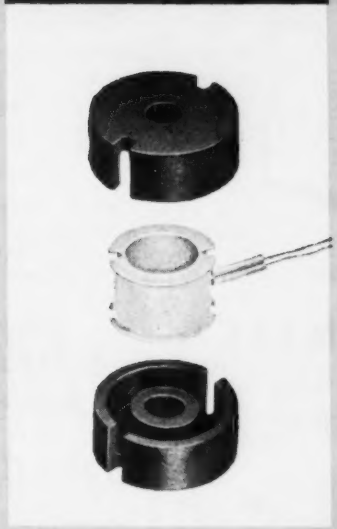
Probing new dimensions in Electronics through Stackpole Research . . .



A MAJOR NEW FERRITE

FOR TELE-COMMUNICATIONS

Permeability: 1800

Temperature Constant: 1.8 x 10^{-6} per °C (—20° to 120° C)

Avg. Temperature Coefficient (un-gapped cores): 0.29% per °C (—20° to 85°C)

μQ (merit factor): Greater than 200,000 at 100 kc

. . . these in brief are the salient electrical characteristics of Stackpole *Ceramag 501*—a remarkable new low-loss ferrite grade for the 10 kc to 250 kc range. Already revolutionizing the design of carrier-current communications filters, the material shows considerable promise for electronic switching circuits and others as well.

Cup cores of Ceramag 501 no larger than a quarter enable the design of filters with such narrow pass bands that message-handling capacities of communications systems can be increased from 2 to over 90 messages per channel. The extraordinary high gain of filters using Ceramag 501 combine with other inherent advantages—smaller size, no aging or life problems—for a significant contribution to system reliability.

But equally significant is the extremely close tolerances to which these cores are made. To achieve the exact air gap required, Ceramag 501 cups are supplied in matched pairs. Special Stackpole-designed mounting hardware and tuning slugs can also be supplied to assure easy assembly and maximum electrical performance with your own coil designs.

Almost four years in development, Ceramag 501 represents another basic contribution based on magnetic ceramic research and engineering by the oldest commercial ferrite producer in the United States.

Complete details on Ceramag 501 and the remarkable research facilities that made it possible are available upon request to the *Electronic Components Division,* Stackpole Carbon Company, St. Marys, Pa.

STACKPOLE *Ceramag*®

FERRITE CORES

CERAMAG® FERRITE CORES • VARIABLE COMPOSITION RESISTORS • SLIDE & SNAP SWITCHES • CERAMAGNET® CERAMIC MAGNETS • FIXED COMPOSITION CAPACITORS BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT • ELECTRICAL CONTACTS GRAPHITE BEARINGS, SEAL RINGS ANODES • HUNDREDS OF RELATED CARBON & GRAPHITE PRODUCTS.

RACAL RADIO-TELETYPEWRITER TERMINAL

FOR AVIATION AUTHORITIES
METEOROLOGICAL SERVICES
PRESS RADIO STATIONS
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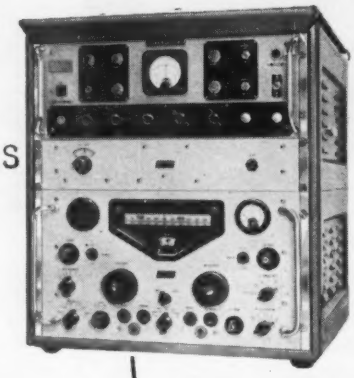
THIS IS IDEAL FOR YOUR
[illegible]POSES+THE EQUIPMENT
[illegible]IDES A FIRST CLASS
[illegible]RINTER SERVICE+
THE RA129 IS SIMPLE TO
OPERATE QUICK TO ALIGN
ACCURATE AND DEPENDABLE
YET VERY LOW IN COST+



TYPE RA.129
Single Channel

TYPE RA.103
Dual Diversity

Frequency Range:
1—30 Mc/s

Tuning:
Continuous without band-switching

Frequency Shift:
150 to 1000 cycles total

Signalling Speeds:
Up to 300 bauds

Output:
Polarised or neutral
Suitable for all teleprinters

Power Supply:
100/125 and 200/250 volts
45/65 c/s AC. 220 watts

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RACAL'S REPRESENTATIVE in the UNITED STATES, Mr. W. J. ZULLO; 104, Highland Avenue, Somerville 43, Mass.

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We specialize in production machines for electrical and electronic needs. Used by leading makers of PW boards for setting funnel flange, standardized, and special eyelets, from smallest sizes to 3/8". Best value on the market.

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Solve your eyelet machine problems fast — Write today.

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31 Carleton Street, Cambridge, Mass.

Wrapped up in a sticky TEFLON tape problem?

Joclin's 16 basic types of Fluorolin® pressure-sensitive Teflon tapes are the broadest line available. When you need a non-stick surface with chemical resistance, rated at 1000 to 4000 v/mil, that withstands temperatures of —100° to +500°F., there's a Joclin tape ideal for your application.

Johnny Joclin says:
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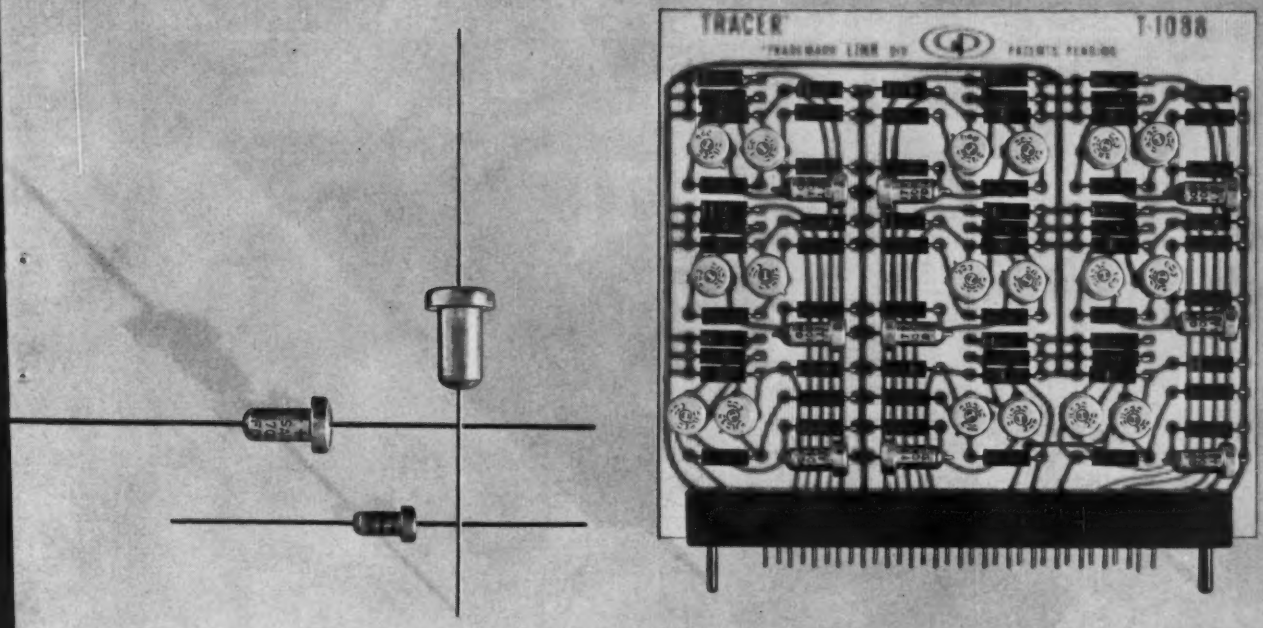
CIRCLE 89 ON READER SERVICE CARD→



Link Division of General Precision, Inc. specified ITT capacitors for this vital portion of its Tracer Identification and Control System, which demands utmost reliability and long life expectancy from every component.

TOTAL PROCESS CONTROL AND DISCIPLINED PRODUCTION DELIVER

HIGH-RELIABILITY WET-ANODE TANTALUM CAPACITORS FROM ITT

ITT wet-anode tantalum capacitors meet MIL-C-3965B—a fact proved by independent laboratory qualifications tests on ITT capacitors. The reliability and long life expectancy of these competitively-priced capacitors are direct results of ITT's total process control and disciplined production procedures, above and beyond testing standards more stringent than normal industry practice—and backed by ITT's world-wide facilities and experience.

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COMPONENTS DIVISION
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
915 SAN ANTONIO RD., PALO ALTO, CALIF.

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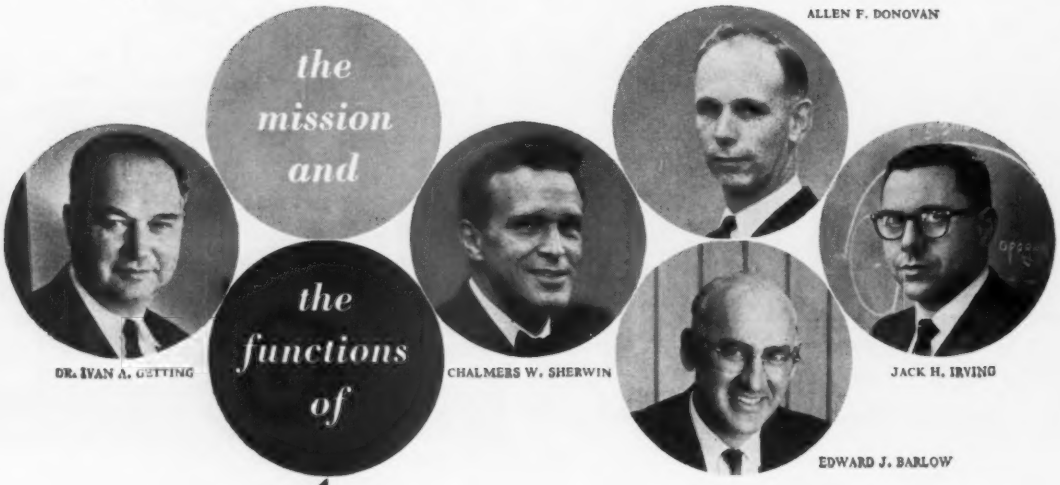
IN STOCK AT ITT DISTRIBUTORS:

- TWO TYPES—M-Type and P-Type, for applications from −55 to 85 and 125 C. respectively
- 29 VALUES—from 1.75 to 330 mfds over a working voltage range to 125 VDC and maximum surge voltages to 140 VDC
- COMPACT AND RUGGED—sintered tantalum slug in fine-silver cases for 2000-hour life at maximum temperature and working voltage
- GUARANTEED—to 80,000 ft. and accelerations of 20 G's with a 0.1 in. excursion in 50-2000 cps range
- LONG STORAGE LIFE—tantalum-oxide dielectric is completely stable; assures trouble-free operation

COMPLETE SPECIFICATIONS ON ITT wet- and solid-anode tantalum capacitors are available on request. Write on your letterhead, please, to the address below.

ENGINEERS: Your ITT representative has a complete set of qualifications and quality control tests for your inspection.



AEROSPACE CORPORATION

present genuine challenge to scientists and engineers of demonstrated competence

"To preserve our free institutions, it is absolutely essential that the United States find the most effective means of advancing the science and technology of space and also of applying them to military space systems. This is the mission of Aerospace Corporation."

IVAN A. GETTING
PRESIDENT
AEROSPACE CORPORATION

In accomplishing its mission, this nonprofit public service organization performs the unique role of space systems architect. Aerospace Corporation provides scientific and technical leadership to the science/industry team responsible for developing complete space and ballistic missile systems on behalf of the United States Air Force.

Specific responsibilities of the new corporation include advanced systems analysis, research and experimentation, initial systems engineering, and general technical supervision of new systems through their critical phases.

The broad charter of Aerospace Corporation offers its scientists and engineers more than the usual scope for creative expression and significant achievement, within a stimulating atmosphere of dedication to the public interest.

Aerospace Corporation scientists and engineers are already engaged in a wide variety of specific systems projects and forward research programs, under the leadership of scientist/administrators including corporation president Dr. Ivan A. Getting, senior vice president Allen F. Donovan, and vice presidents Edward J. Barlow, William W. Drake, Jr., Jack H. Irving, and Chalmers W. Sherwin.

Aerospace Corporation is currently seeking scientists and engineers capable of meeting genuine challenge and with proven ability as:

- SENIOR ELECTRONICS ENGINEERS
  - Communications systems
  - Guidance electronics
  - Data processing systems
  - Radio techniques
  - Electromechanical design
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- SPACE VEHICLE SPECALISTS:
  - Senior power systems engineer
  - Sr. flight performance analyst
  - Re-entry aerodynamicist

Those qualified and experienced in these and related fields are urged to direct their resumes to:

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A new and vital force AEROSPACE CORPORATION *engaged in accelerating the advancement of space science and technology*

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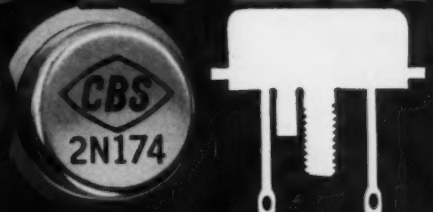
NEW CBS HIGH-POWER TRANSISTORS



Advantages

- High power output: up to 30 w Class A, 100 w Class B, 1000 w switching
- High voltages . . . high current gains . . . and high working currents
- Low-distortion ring emitter construction
- Hermetically welded JEDEC TO-36 male industrial case

Characteristics

All these CBS high-power transistors have: Max. dissipation, 150 watts* for a typical thermal resistance of 0.5° C/W; max. collector current, 15 amperes; junction temperatures, −65 to +100°C.

Type	Max. W. Diss.*	Max. Thermal Res°C/W	Max. V_{CBO}	Max. V_{CES}	h_{FE} (I_C = 5A) Min.	Max.
2N173	70	1.0	60	50	35	70
2N174	85	0.8	80	70	25	50
2N277	70	1.0	40	40	35	70
2N278	70	1.0	50	45	35	70
2N441	70	1.0	40	40	20	40
2N442	70	1.0	50	45	20	40
2N443	70	1.0	60	50	20	40
2N1100	85	0.8	100	80	25	50

*25°C base mounting temperature.

save costs • space • weight

You can now replace two 40-watt or four 20-watt paralleled power transistors with one CBS PNP high-power transistor. This one design change brings you important transistor . . . component . . . assembly . . . space . . . and weight savings. New economies become possible in power supplies and amplifiers and in high-power switching circuits.

Note the wide line of these CBS PNP high-power transistors, their pertinent characteristics and many advantages. Ask for complete technical data. Order these money-saving units today . . . at factory prices for quantities up to 1000 . . . from your Manufacturers Warehousing Distributor.

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CBS ELECTRONICS, Semiconductor Operations, Lowell, Mass. • A Division of Columbia Broadcasting System, Inc.

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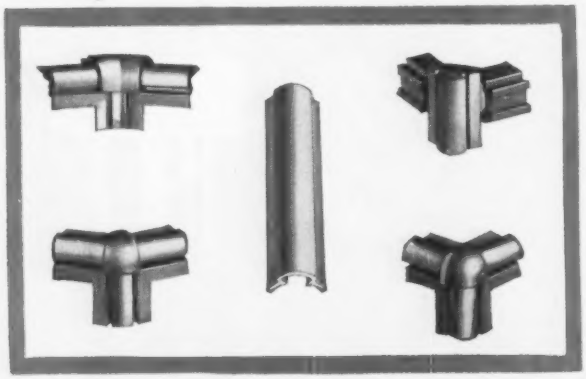
your ingenuity

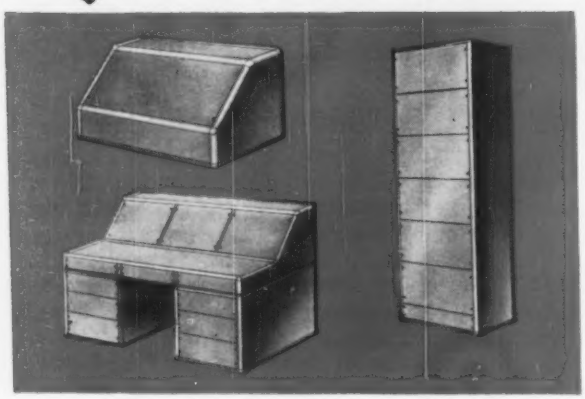
PLUS simple tools can transform

BUD *IMLOK*

↓ extrusions and connectors



↓ into housings like these



When you need cabinets, racks or cases for experimental or prototype work, make them quickly and inexpensively with BUD IMLOK extrusions and connectors. No tooling costs or expensive labor are involved. More than 50 different styles of connectors, extrusions and accessories are easily locked together to form the framework of any type housing. Aluminum or steel sheets complete the enclosure.

The new BUD IMLOK manual gives complete details on this system. Write us for a copy or obtain one at your local BUD distributor.

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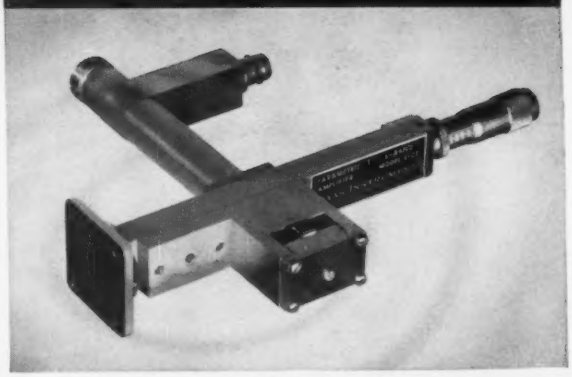
NOW. . . S-BAND, NON-DEGENERATE AMPLIFIERS

with bandwidths up to 75 mc at 15 db gain!



FOR MILITARY ENVIRONMENTS!

Broadband parametric amplifiers for applications at L, S, C, and X band are available now from Texas Instruments. The S-band model, designed with a TI XD-500 gallium arsenide diode, gives bandwidths up to 75 mc at 15 db gain. Gain variation is no greater than 3 db over temperatures ranging from −40°C to +50°C, and the unit meets the vibration requirements of MIL-E-5400D. Noise figure, including circulator loss is 3 db. The associated circulator is a miniaturized, three-port ferrite unit with 0.5 db insertion loss and 20 db isolation.

TYPICAL MODEL S-22 SERIES SPECIFICATIONS	
frequency	2.8 to 2.96 Gc
bandwidth	40 mc
gain	15 db
noise figure (includes circulator loss)	3 db
pump frequency	X band
diode	Texas Instruments XD-500 $F_c \geqq 70$ kmc at −2v bias
temperature range	−40°C to + 50°C
vibration.	per MIL-E-5400D
pump power	50 mw

For details on TI's S-band amplifiers, write for Bulletin No. DLA-1217. For information on specific applications at all frequencies, contact MARKETING DEPARTMENT.

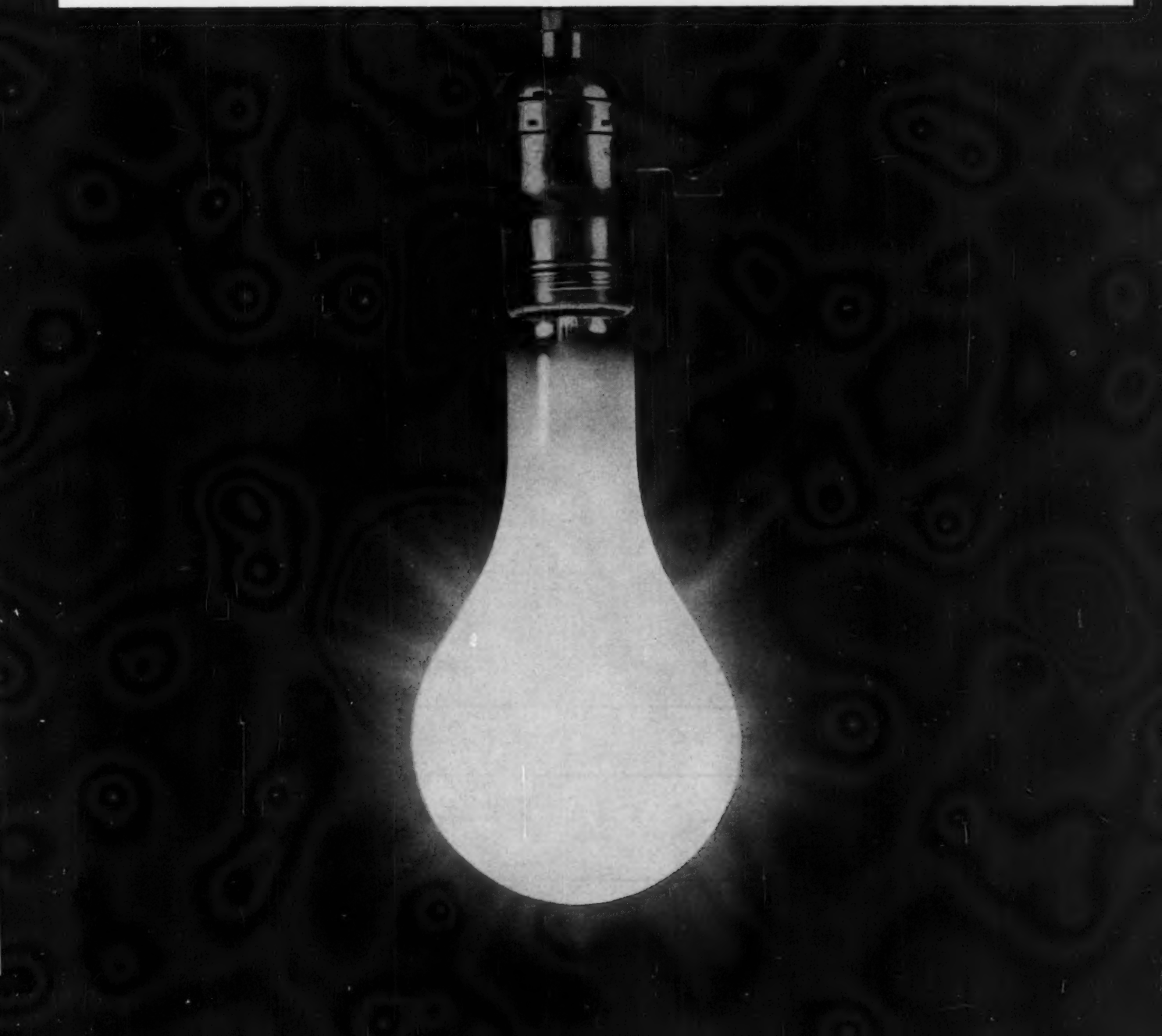
TEXAS INSTRUMENTS
INCORPORATED
APPARATUS DIVISION
P. O. BOX 6015
DALLAS 22, TEXAS

NEW LIGHT is shed daily on microwave tube state-of-the-art by the engineers and scientists at Sperry's Gainesville, Florida plant. If existing hardware doesn't readily solve your tube application problem, call Gainesville, FRanklin 2-0411 collect, for full information about Sperry capabilities.

SPERRY ELECTRONIC TUBE DIVISION

Gainesville, Florida • A Division of Sperry Rand Corporation

A COMPLETE LINE of klystron tubes is manufactured and marketed by Sperry Electronic Tube Division, Gainesville, Fla. The division also performs extensive research and development toward advances in klystron state-of-the-art.



the 42 most popular ®REGATRON POWER SUPPLIES are programmable

MODEL 212A $129 WITHOUT METERS

0.1% REGULATION MODELS	DC OUTPUT VOLTS	DC OUTPUT MA	0.01% REGULATION MODELS
220A	0-50	0-500	220AK
213A	0-50	0-1000	213AK
215A	0-50	0-3000	215AK
225A	0-75	0-2000	225AK
212A[1]	0-100	0-100	212AK[1]
2-212A[1, 3]	0-100X2	0-100X2	2-212AK[1, 3]
224A[1]	0-100	0-200	224AK[1]
221A	0-100	0-500	221AK
214A	0-100	0-1000	214AK
226A	0-100	0-2000	226AK
218A	0-100	0-3000	218AK
229A	0-150	0-300	229AK
228A	0-150	0-1000	228AK
230A	0-200	0-1000	230AK
231A[2]	0-300	0-100	231AK[2]
232A[2]	0-300	0-200	232AK[2]
233A[2]	0-300	0-300	233AK[2]
234A	0-300	0-500	234AK
237A	0-300	0-1000	237AK
236A[2]	0-600	0-200	236AK[2]
235A	0-600	0-500	235AK

[1] Has modulation input.
[2] Has additional 0-150 V DC output and 6.3 V AC CT output.
[3] Equivalent to two Model 212A's.

Why programmable? Because Regatron Programmable Power Supplies give the design engineer an extra margin of versatility. For example, in automatic test work, the programmable feature reduces control circuitry. In critical laboratory application, the programmable feature permits near-perfect reproducibility of test voltages.

There are other advantages too. The programmable feature provides for remote sensing. This provision eliminates the effect of voltage drops in power leads . . . places the point of regulation at the load terminals. And there's more.

For complete descriptions and specifications ask for Specification Sheets 3010B and 3023B.

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SPEED GRIPS® hold themselves on panels!

Wherever you require a heavy-duty, multi-thread, self-retaining fastener, a Tinnerman SPEED GRIP Nut Retainer answers the need, holds down assembly costs.

SPEED GRIPS snap into place... some into panel holes... others over panel edges. No special tools or skills required. Spring-steel fingers grip the panel, yet let the nut float to compensate for normal panel-hole misalignment. Welding, staking and clinching are eliminated. SPEED GRIPS can even be applied after panels have been finished, avoiding paint-clogged threads.

SPEED GRIPS are available in a wide range of sizes and types, including front-mounting nut and bolt retainers for hard-to-reach or blind locations.

See your Sweet's Product Design File, section 8-T for data on these and other SPEED NUT Brand Fasteners. Your Tinnerman representative has complete information and samples. If he isn't listed under "Fasteners" in your Yellow Pages, write to:

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Speed Nuts®

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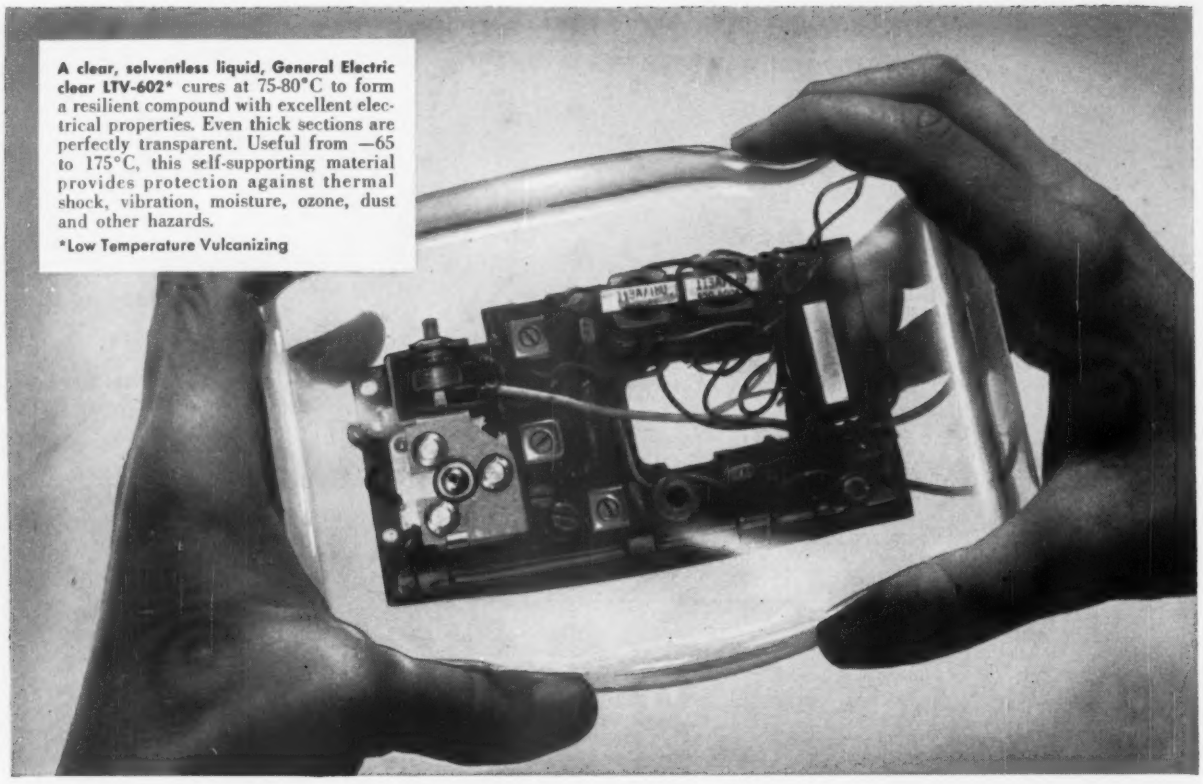
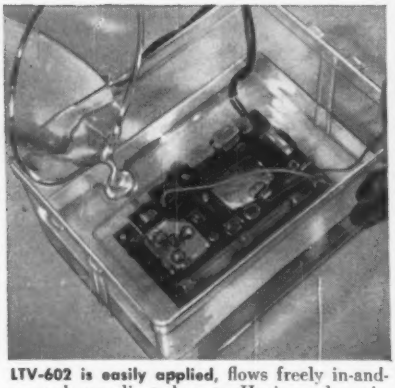


A clear, solventless liquid, General Electric clear LTV-602* cures at 75-80°C to form a resilient compound with excellent electrical properties. Even thick sections are perfectly transparent. Useful from —65 to 175°C, this self-supporting material provides protection against thermal shock, vibration, moisture, ozone, dust and other hazards.

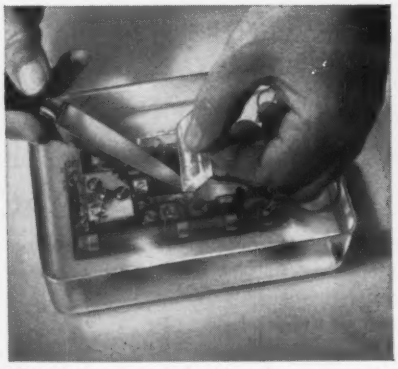
*Low Temperature Vulcanizing

General Electric clear LTV silicone compound for potting and embedding

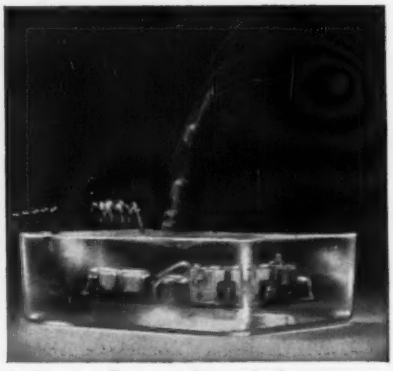
Transparent, resilient, self-supporting and easy to repair



LTV-602 is easily applied, flows freely in-and-around complicated parts. Having a low viscosity in the uncured state, 800-1500 centipoise, LTV is ideal for potting and embedding of electronic assemblies. Unlike "gel-like" potting materials, LTV-602 cures to a flexible solid. Oven cure is overnight, or from 6 to 8 hours at 75 to 80°C.



LTV-602 is easy to work with and easy to repair. To repair parts embedded in LTV, merely cut out and remove section of material, repair or replace defective part, pour fresh LTV into opening and cure. Pot life, with catalyst added, is approximately 8 hours and may be extended with refrigeration. When desirable, LTV may also be cured at room temperature.



Resiliency offers excellent shock resistance. LTV-602 easily meets thermal shock tests described in MIL-STD-202A test condition B which specifies five temperature cycles from —65 to 125°C. Tests indicate that LTV retains protective properties even after 1800 hours aging at 175°C. Other tests confirm LTV's resistance to moisture and water immersion.

LTV-602 is the newest addition to the broad line of G-E silicone potting and encapsulating materials which also include the RTV silicone rubbers. For more information, write to General Electric Company, Silicone Products Department, Section N240, Waterford, New York.

GENERAL ELECTRIC

look into Panoramic's new SPA-4a exclusive features for more reliable spectrum analysis 10 mc to 44,000 mc

2 to 4 TIMES THE USABLE SENSITIVITY

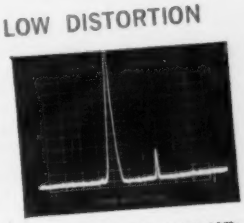
Lower internal noise enables analysis of even smaller signals than before (see chart)... accurate measurement of more highly dispersed energies, as typified by extremely narrow pulsed signals.

BAND	RF SENSITIVITY*
1- 10 – 420 MC	–100 to –110 dbm
2- 350 – 1000 MC	– 95 to –105 dbm
3- 910 – 2200 MC	–100 to –110 dbm
4- 1980 – 4500 MC	– 90 to –100 dbm
5- 4.5 – 10.88 KMC	– 90 to –100 dbm
6-10.88 – 18.0 KMC	– 85 to –100 dbm
7- 18.0 – 26.4 KMC	– 70 to – 90 dbm
8- 26.4 – 44.0 KMC	– 60 to – 85 dbm

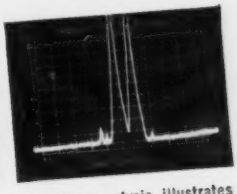
*measured when signal and noise equal 2x noise

EXCEPTIONALLY LOW DISTORTION

Reduced threshold allows SPA-4a to operate at smaller input signal levels (and attenuated larger ones). Unretouched screen photos show how this permits virtually spurious-free measurement—over a wide dynamic range—of harmonics, in-band distortion, and other weak signals in the presence of strong ones.



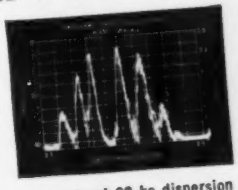
Extended dynamic range comparison of 2 signals on SPA-4a. Larger is + 15 db over full scale log. Smaller is at –28 db on scale or –43 db from larger. Note exceptional freedom from spurious. (Photo not retouched)



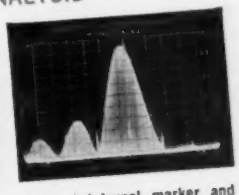
Distortion analysis illustrates SPA-4a wide range linearity. Odd-order distortion here is measured more than 50 db below level of 2 main tones (deflected 20 db above full scale). Photo unretouched.

HIGHLY RESOLVED & CALIBRATED ANALYSIS

Reduced internal hum improves resolution of closely spaced signals; also improves minimum dispersions for more highly magnified analyses. Marker modulation permits highly accurate measurements of frequency differences during high speed analysis. See photos.



Narrow band 20 kc dispersion analysis shows unique resolution capability. Here, a 1000 mc FM signal with 2 kc modulation is seen near first carrier null. Photo unretouched.



Pips of internal marker and sidebands (ext. mod.≃100 kc) accurately measure pulse width in spectrum of 10μs. radar pulse. Upper lobes seen to be very small. (Unretouched)

dependable CERTIFIED SPECIFICATIONS for accurate data

The SPA-4a's exclusive features also include:

1. **ONE TUNING HEAD** – 10 mc to 44,000 mc, utilizing 3 stabilized, low hum local oscillators (1 HF triode and 2 klystrons). Fundamentals to 11 kmc. Direct reading with ± 1% accuracy.
2. **TWO INDEPENDENT FREQUENCY DISPERSION RANGES:** Continuously adjustable; 0-70 mc with exceptional flatness, stable 0-5 mc for narrow band analysis. Both swept local oscillators operate on fundamentals only for spurious-free analysis.
3. **PUSH-BUTTON FREQUENCY RANGE SELECTOR.**
4. **ADJUSTABLE IF BANDWIDTH 1 KC to 80 KC.**
5. **3 CALIBRATED AMPLITUDE SCALES** – 40 db log, 20 db lin, 10 db power.
6. **SYNCHROSCOPE OUTPUT WITH 40 DB GAIN.**
7. **SWEEP RATE ADJUSTABLE FROM 1-60 CPS.** May be set free running, synchronized to the line or to external prf. Also provisions for sweep rate calibrations.

Important as these advantages are, there are many more.

Easy to use, too... human engineered for simple operation, component accessibility.

The advanced new SPA-4a is unmatched for visually analyzing FM, AM and pulsed signal systems —instabilities of oscillators —noise spectra—for detection of parasitics—studies of harmonic outputs, radar systems and other signal sources.

Write, wire, phone today for detailed SPA-4a specification bulletin and new Catalog Digest.

Sec. 2900

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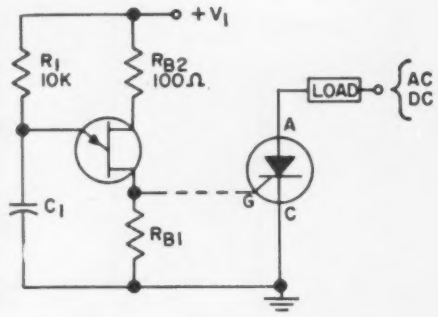
Now...G-E Unijunction Transistors give you silicon performance at germanium prices



The 2N1671A and 2N1671B offer *guaranteed* characteristics for firing General Electric Silicon Controlled Rectifiers. Supply voltages and component values are easily determined from a single graph on the specification sheet.

Typical Circuit Comparisons—Because of its unique characteristics, one unijunction transistor can often replace two conventional transistors with significant savings in overall circuit cost. You can simplify circuit requirements and at the same time achieve improved stability over a wide temperature range.

Transistor Time Delay Circuit	Unijunction Circuit Equivalent
3 transistors*	1 unijunction transistor
1 diode	1 Zener diode
1 Zener diode	1 relay
1 relay	1 capacitor
2 capacitors	4 resistors
8 resistors	

SAVINGS: $3.30 (*germanium transistors)
$16.50 (*silicon transistors)

Transistor Voltage Detector	Unijunction Circuit Equivalent
2 transistors*	1 unijunction transistor
1 potentiometer	1 potentiometer
2 capacitors	1 capacitor
5 resistors	3 resistors

SAVINGS: $0.40 (*germanium transistors)
$9.20 (*silicon transistors)

Types 2N1671, 2N1671A, and 2N1671B are the latest additions to the General Electric line of silicon unijunction transistors . . . at a price comparable to germanium transistors. A unique type of semiconductor device proved in over three years of production and application, silicon unijunction transistors feature stable negative resistance characteristics, extremely low trigger currents, stable trigger voltages, and high pulse current capabilities.

The 2N1671 is intended for general purpose industrial applications where circuit economy is the prime consideration. The 2N1671A features a guaranteed minimum pulse amplitude, and is characterized for use in firing circuits for Silicon Controlled Rectifiers. The 2N1671B features low emitter leakage current and low trigger current, making it the most sensitive semiconductor triggering device available.

Price reductions have also been made on standard unijunction types 2N489 through 2N494. For complete technical data and application information for all unijunction transistor types, see your G.E. Semiconductor District Sales Manager. Or write section 25B87, Semiconductor Products Dept., General Electric Company, Electronics Park, Syracuse, New York. In Canada: Canadian General Electric Company, 189 Dufferin Street, Toronto, Ontario. Export: International General Electric Company, 150 E. 42nd St., New York, N. Y.

CONDENSED SPECIFICATIONS OF UNIJUNCTION TRANSISTORS 2N1671, A, B

Maximum Total Power Dissipation		450 mw
Operating Temperature Range		−65°C to 140°C
Intrinsic Standoff Ratio (η)		0.47 to 0.62
Interbase Resistance (R_{BB})		4.7K to 9.1K
Peak Point Emitter Current (I_P) (V_{BB}=25 volts)	2N1671,A 2N1671B	25 μa max. 6 μa max.
Emitter Reverse Current (I_{EO}) (V_{EB2}=30 volts)	2N1671,A 2N1671B	12 μa max. 0.2 μa max.
Base—One Peak Pulse Voltage	2N1671A,B	3 volts min.

(In SCR circuit shown, V_1=20V, C_1=0.2 μfd, R_{B1}=20Ω)

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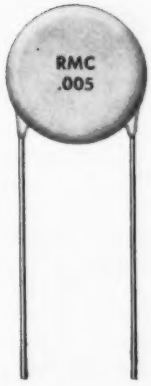
This new factory, office and research center in Chicago will enable RMC to expand its service to the growing electronic industry. The modern facility incorporates extensive manufacturing space to provide the fastest shipments of RMC DISCAPS with up to the minute research laboratories where technicians are engaged in capacitor development and improvement.



The combination of this new facility with RMC's modern plant in Attica, Indiana, enables Radio Materials Company, now, more than ever, to better serve your ceramic capacitor requirements efficiently and economically.

DISCAP CERAMIC CAPACITORS

RMC

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FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

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TOUGH

...AS A TURTLE'S BACK

ARMAG*-PROTECTED DYNACOR® BOBBIN CORES AT NO EXTRA COST!

Tough-as-tortoise-shell Armag armor is an exclusive Dynacor development. It is a thin, non-metallic laminated jacket for bobbin cores that replaces the defects of nylon materials and polyester tape *with very definite advantages* —and, you pay no premium for Armag extra protection.

Tough Armag is suitable for use with normal encapsulation techniques on both ceramic and stainless steel bobbins. It withstands 180°C without deterioration—is completely compatible with poured potted compounds—has no abrasive effect on copper wire during winding—fabricates easily to close-tolerance dimensions—inner layer is compressible to assure tight fit on bobbin—does not shrink, age or discolor.

Write for Engineering Bulletins DN 1500, DN 1000A, DN 1003 for complete performance and specification data covering the wide range of Dynacor low cost Standard, Special and Custom Bobbin Cores—all available with Armag non-metallic armor.

*TRADEMARK

DYNACOR

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Old Fashioned?

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Davey-Paxman Vertical Boiler • Davey-Paxman & Co.• Circa 1876

CIRCLE 204 ON READER SERVICE CARD

Said Isaac Newton:

"Every particle of matter attracts every other particle with a force directly proportional to the product of their masses and inversely proportional to the square of the distances between them."

Until recently, the thrust which propelled rocket vehicles into their coast stage, prior to orbiting, was provided by booster stages. The fuel carried by the satellite stage was used only to inject itself into orbit.

Now, however, a scientist at Lockheed Missiles and Space Division has evolved a Dual Burning Propulsion System which allows higher orbits and heavier payloads. With this system, the satellite vehicle fires immediately after the last booster stage burns out, thus augmenting the begin-coast speed. Later the satellite stage is re-started to provide orbit injection.

An even more recent development by Lockheed is a triple-burning satellite stage. This will permit a precise 24-hour equatorial orbit, even though the vehicle is launched a considerable distance from the equator.

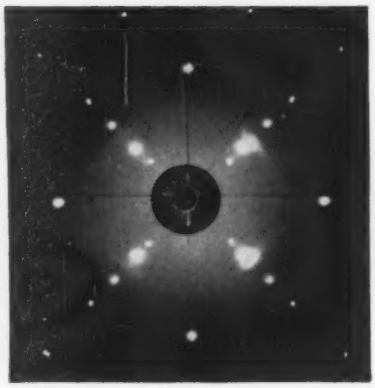
These principles have made possible the early development of the MIDAS satellite. Moreover, they substantially increase the altitude and payload of the DISCOVERER series. Lockheed, Systems Manager for these programs and for the POLARIS FBM, is pursuing even more advanced research and development projects. As a result, there are ever-widening opportunities for creative engineers and scientists in their chosen fields.

Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-15B, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed / MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and MIDAS Programs

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • HAWAII



Opening up broad new horizons for the next generation of semiconductor devices.

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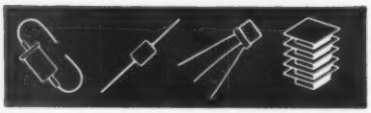
- Infra Red Detectors
- Magneto Resistive Transducers
- Thermo Electric Generators



Also commercially available are Single Crystals of:

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Call on our experienced Engineering Staff to assist you in the selection of Single Crystal Materials.

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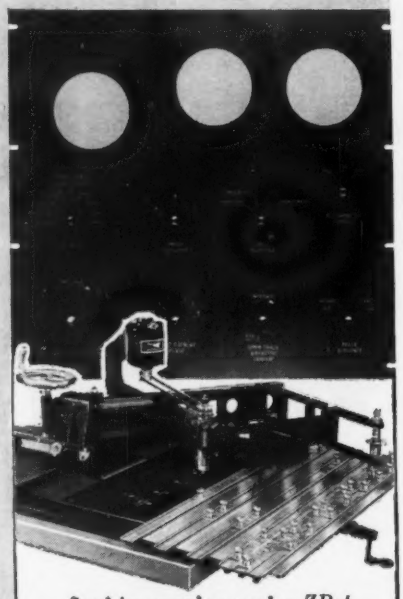
any size panels

engraved in your own plant



Engrave 1-inch nameplates or 6-foot panels by unskilled labor.

Spindle covers 18¼" x 6" in one set-up — more than any other machine of its kind.

Bench type model I-R—$685.

Send for complete catalog ZR-4 illustrating other models from $325 up

new hermes **ENGRAVING MACHINE CORP.**

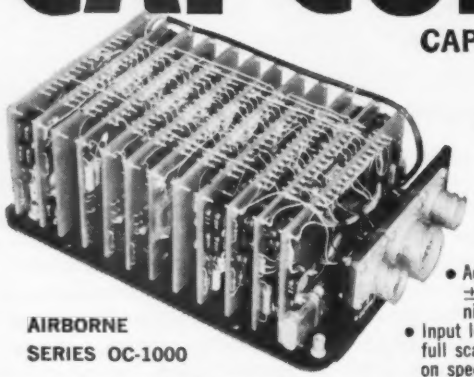
154 WEST 14th STREET, NEW YORK 11, N. Y. IN CANADA: 359 St. James Street West, Montreal, P. Q.

CIRCLE 205 ON READER SERVICE CARD

CAPCODER

CAPACITIVE CHARGE TRANSFER ANALOG-DIGITAL CONVERTER

Patent Applied for



AIRBORNE
SERIES OC-1000

- 10 bits, serial binary NRZ output
- 200,000 bits per second
- Internal continuous encoding at 18,181 encodings per second or encode upon command

- Resolution 1/1024 of full scale
- Accuracy ±.05% of full scale ±½ the value of the least significant digit
- Input level 0 to +5v or ±2.5v. Input full scale ranges of 1 to 10v available on special order
- 1 megohm input impedance; includes sample and hold
- Approximately 6 watts input power; standard power supplies available
- Fully transistorized
- 3" x 5" x 7½", 3.25 lbs.

TOWSON LABORATORIES, INC.

200 E. JOPPA ROAD • BALTIMORE 4, MD. • VALLEY 5-6361

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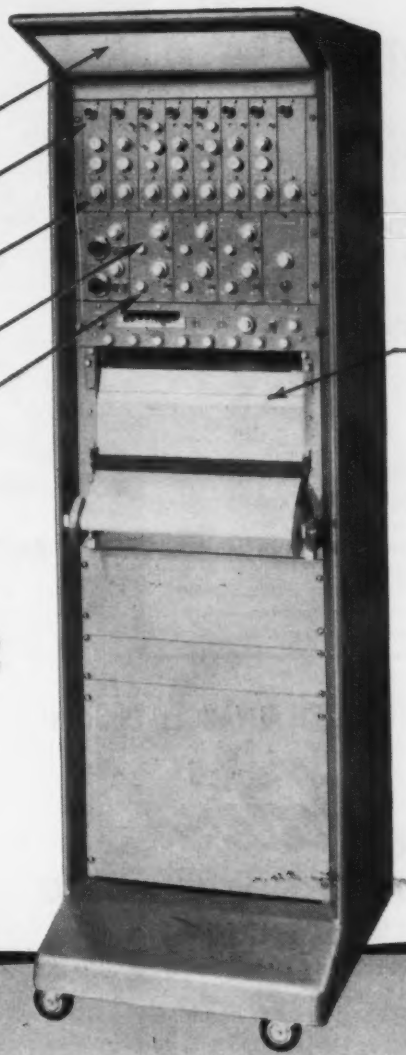
OFFNER
ALL TRANSISTOR

TYPE R DYNOGRAPH

the most versatile . . . most sensitive direct writing unit available



Illuminated canopy

Type 9800 series input couplers provide all input, control and balance functions. Input available both front and rear.

Type 481 Preamplifier provides sensitivities from one microvolt to 5 volts per mm.

Type 482 power amplifiers—may be used without preamplifiers for up to 10 mv/cm sensitivity

Zero suppression control

504-A paper drive—speeds from 1 to 250 mm/sec. Electrical speed shift 1 to 250 mm per minute available. Zero weave high precision drive, 850 ft. capacity (heat or electric) 1500 ft. (ink). Front loading, with full unobstructed record visible from front.

Combining all these features...

- *stable d-c sensitivity of one microvolt per mm*
- *true differential input*
- *high input impedance*
- *response to beyond 150 cps.*
- *reluctance, differential transformer, strain gage with a-c or d-c excitation, thermocouples, etc., used with all preamplifiers*
- *deflection time less than 1.5 milliseconds (2.5 ms with preamplifiers)*
- *fixed precision calibration*
- *instant warm-up*
- *precision source for d-c and 400 cycle excitation, self-contained*
- *zero suppression, twenty times full scale, both directions*

FULL SCALE, UNRETOUCHED CHARTS PRODUCED ON THE TYPE R DYNOGRAPH

EXTREME SENSITIVITY

10 Microvolt RMS Sine Wave — **Ten Microvolt D-C Square Wave**

Four recording media. Heat or electric rectilinear—ink or electric curvilinear. Readily convertible.

All these features . . . plus 8 channels in only 35" of rack space. Whatever your application for direct writing records . . . you should investigate the ability of the Offner Type R Dynograph to do the job *better* and more *simply*. Using transistor circuits* developed and tested for over three years in thousands of channels of Offner equipment, the Type R Dynograph has already proved its superiority in practically every respect to *any other* direct writing oscillograph. Write on your company letterhead for literature giving details and specifications.

**Patents granted and pending*

OFFNER ELECTRONICS INC.

3936 River Road, Schiller Park, Ill.
(Suburb of Chicago)

CIRCLE 103 ON READER SERVICE CARD

Designed for M *Application*

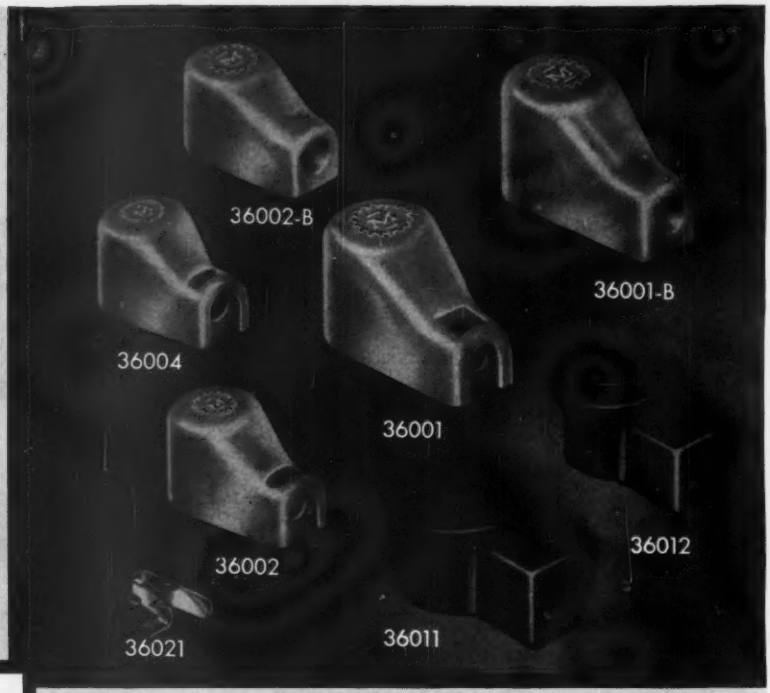


PLATE AND GRID CAPS

Illustrated are the stock military and standard ceramic Millen plate and grid caps and the snap lock caps for mobile and industrial applications requiring tighter than normal grip. Standard plate caps have phosphor bronze clips; military plate caps have beryllium copper clips.

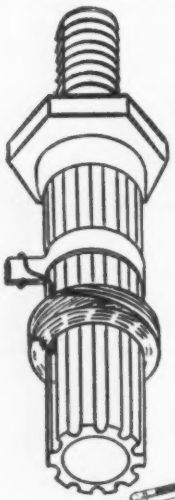
JAMES MILLEN MFG. CO., INC.

MALDEN

MASSACHUSETTS

CIRCLE 207 ON READER SERVICE CARD

LEADS THE FIELD WITH ADVANCED DESIGN!



Waters

RIBBED CERAMIC COIL FORMS

with internal torque

Ribbed ceramic eliminates loose leads — permits you to feed wire lead under pie winding to terminal lug, when necessary.

DELIVERY FROM STOCK! NO WAITING!

SEND FOR THIS EXPERIMENTAL PROTOTYPE KIT

Why guess? Develop production requirements accurately. Contains 8 samples with a frequency range of 0.1 to 200 mc, in both ribbed and plain round designs. Sizes .205 dia. to .500 dia. Price $5.00

Waters

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Allen Avionics provides free engineering consultation services, which project engineers have found to be extremely useful. By consulting with Allen before freezing their delay line specs, project engineers have been able to effect major savings in time and money plus the elimination of needless delay line sophistication. Allen's services are uniquely slanted towards complete systems knowledge so that recommendations are made with your entire system in mind. Find out how these services can aid you in your next time delay application. Call or write today.

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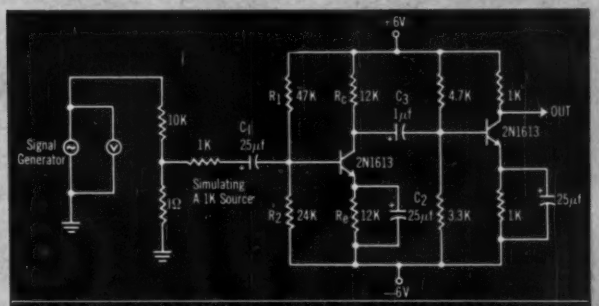
Phone: Pioneer 7-5450

CIRCLE 208 ON READER SERVICE CARD

Make sure to visit the Fairchild Exhibit, Booths 2705-2707 on the second floor at the IRE Show

Fairchild's **planar** 2N1613 starts with low leakage (10mμA), high alpha cutoff (120mc) and excellent beta over a wide collector-current range (see specifications). Oxide-protected surfaces and junctions — a unique Fairchild **planar** advantage — keep operating parameters stable throughout transistor life to prevent creeping incremental noise buildup.

LOW-NOISE TRANSISTOR CIRCUITRY



2N1613 SPECIFICATIONS — 25° C EXCEPT AS NOTED

		MIN.	TYP.	MAX.	CONDITIONS	
h_{FE}	DC pulse current gain	40		120	I_C=150mA	V_C=10V
h_{fe}	Small-signal current gain	3.0	5		I_C=50mA f=20mc	V_C=10V
C_{ob}	Collector capacitance		18$\mu\mu$f	25$\mu\mu$f	I_E=0mA	V_C=10V
I_{CBO}	Collector cutoff		0.8mμA 1.0μA	10mμA 10μA	V_C=60 V_C=60	T=25° C T=150° C

LOW-NOISE, LOW-LEAKAGE PLANAR CHARACTERISTICS IN THE FAIRCHILD 2N1613 ARE THE KEY

Low overall noise in this example of a transistor amplifier circuit comes from use of transistors with ideal low-noise characteristics. "Flicker" and "shot" noise — the low- and high-frequency components of transistor noise — are uniquely minimized by the **planar** 2N1613.

Detailed Application Notes disclose complete design and operation considerations for low-noise transistor circuitry. May we send you your copy?

FAIRCHILD SEMICONDUCTOR CORPORATION

A Wholly Owned Subsidiary of Fairchild Camera and Instrument Corporation

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LET'S TALK ABOUT PEDESTALS

The Greeks had a word for it, which escapes us at the moment. And we should have a better word for it, but we haven't. In this day and age, a pedestal is not a simple device to hold something up. Rather, at least in the electronics industry, it is a unique and complex portion of an antenna system.

Canoga designs, develops and manufactures rugged, reliable, light-weight, low-cost pedestals for almost any radar and telemetry, optical and infra-red use—land-based, ship-borne, on trailers, on roof-tops; for use in the arctic, in the desert or in the tropics.

Canoga pedestals are slim, minimizing wind loading and permitting the mounting of counter-balances significantly closer, thereby greatly reducing polar moments of inertia. Gear trains and related electronics are completely enclosed—providing protection from weather, fouling, corrosion, breakage, etc. Up to 810° of travel are available without slip-rings for non-rotational tracking and slip-ring models are available for all around tracking capability. (Canoga has developed the Tri-Ped antenna which provides complete flexibility by the addition of a third, or traverse, axis to the conventional azimuth and elevation axes.)

A single stowing lock secures both elevation and azimuth gears and disengages servos in one operation. Elevation of 200° permits "plunging" for boresight purposes.

Canoga pedestals offer compact, double planetary, interchangeable drive modules with eccentric backlash adjustment, modular interchangeable data packages, balanced elevation yoke which eliminates eccentric loading of the azimuth bearing, yielding increased high-elevation angle accuracy and minimizing the perpendicularity problem. Also, a synchro-torque transmitter hand-wheel follow-up feature eliminates unexpected pedestal accelerations when switching from the slaved to local mode of operation.

Canoga pedestals can accommodate paraboloidal dish antennas up to 28' in diameter and various helix arrays.

Standard bolt circle and bolt dimensions provide for adaptability to standard mounts or mounting can be engineered to customer specifications.

Canoga Electronics Corporation also manufactures complete radar systems, microwave ferrite devices and components, radar and telemetry antennas, radar reflectors, range instrumentation, test equipment and special electronics equipment to customer specifications. **canoga**

CANOGA ELECTRONICS CORPORATION, VAN NUYS, CALIFORNIA • FORT WALTON BEACH, FLORIDA

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first choice of all 4

research

design

production

management

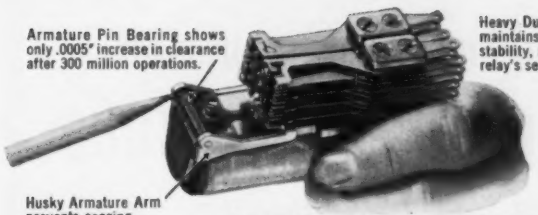
Because the BUYERS' GUIDE satisfies the buying and specifying needs of all four segments of the industry! Gives more information in less space. Easier to use. Only the BUYERS' GUIDE has been *screened for usefulness* over a 20 year period . . . comes to you compact, complete and accurate.

gives more to all 4!

electronics BUYERS' GUIDE and REFERENCE ISSUE

HERE'S WHY P&B TELEPHONE TYPE RELAYS GIVE YOU

reliable performance over long life


Armature Pin Bearing shows only .0005" increase in clearance after 300 million operations.
Heavy Duty Frame maintains dimensional stability, adds to relay's sensitivity.
Husky Armature Arm prevents sagging or bending.

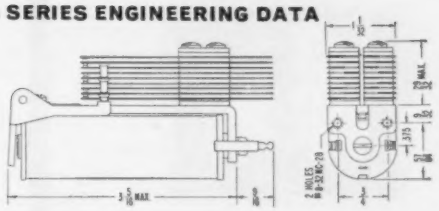
BS SERIES TELEPHONE TYPE

Measure the thickness of the BS series armature arm. You will find the cross section area is greater than ordinary relays of this type. Here is the kind of quality that spells dependability.

Observe that the stainless steel hinge pin runs the full width (not just half) of the armature, providing optimum bearing surface. This pin, operating in a stainless steel sleeve, shows only minimal wear during nearly a *third of a billion operations.*

Best of all, P&B quality costs no more. A whole new plant is being devoted to the production of high performance telephone type relays. Your nearest P&B sales engineer will be happy to discuss your relay problems. Call him today.

BS SERIES ENGINEERING DATA



GENERAL:
- **Breakdown Voltage:** 1000 volts rms 60 cy. min. between all elements.
- **Ambient Temperature:** −55° to +85° C. +125° C available on special order.
- **Weight:** 9 to 16 ozs.
- **Terminals:** Pierced solder lugs; Coil: One #16 AWG wire Contacts: Two #18 AWG wires
- **Enclosures:** Dust covered or sealed

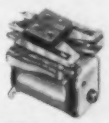
CONTACTS:
- **Arrangements:** DC—up to 28 springs AC—up to 24 springs
- **Material:** ⅛" dia. twin palladium. Up to ¼" dia. single silver. Other materials on special order.
- **Load:** 4 amps at 115 volts, 60 cycle resistive
- **Pressure:** 15 grams minimum

COILS:
- **Resistance:** 100,000 ohms maximum Current: 10 amps maximum
- **Power:** DC—50 Milliwatts per movable arm. Greater sensitivity on special order. AC—17.9 volt-amps.
- **Duty:** Continuous
- **Treatment:** Centrifugal impregnation
- **Voltages:** DC—up to 300 volts with series resistor. AC—up to 250 volts, 60 cy.

MOUNTING: Two #8-32 tapped holes ¾" o.c. Other mountings on special order.

GS SERIES—Excellent sensitivity: 50 mw per movable arm minimum (DC). For applications requiring many switching elements in small space.

LS SERIES—Medium coil relay with short springs and light weight armature for fast action, reliability and long life.



TS SERIES—Short coil relay is available in AC and DC versions. Long life construction. Can be supplied (DC) with up to 20 springs (10 per stack).

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA

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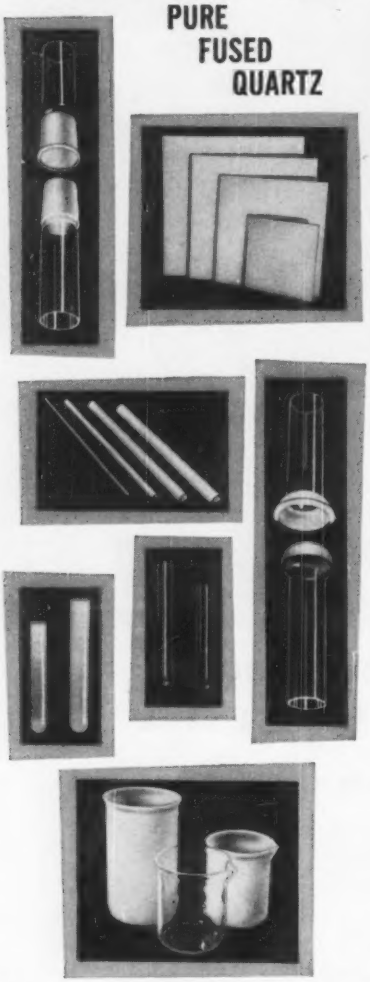
VITREOSIL®

PURE FUSED QUARTZ



SILICON NEWS from Dow Corning

(PART 2)

The Untouchables

Single Crystal Silicon... the "Pinnacle of Purity"

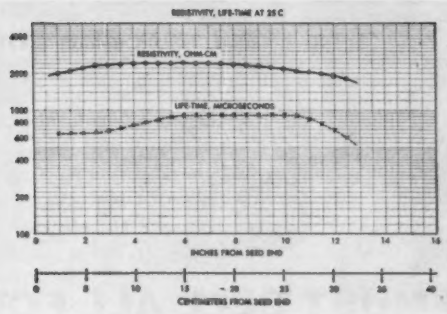
Dow Corning single crystal silicon is produced by vacuum zone refining hyper-pure polycrystalline rod. Result: The purest silicon produced! Typically, impurity content is only 0.15 part per billion of boron for crystals that are consistently above 1000-ohms centimeter resistivity. Boron content is even lower for crystals of 2000-ohms centimeter and above . . . available on a selective basis.

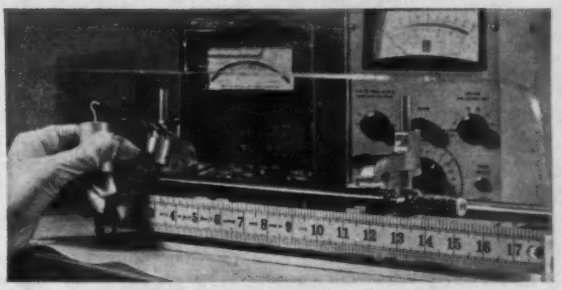
This highest purity P-type silicon is the result of a completely integrated processing facility that starts with the production of trichlorosilane and ends with the crystals heat-sealed in airtight polyethylene envelopes. Purity and quality control dominate every step — in producing the basic chemicals . . . in growing polycrystalline rod . . . in vacuum zone refining . . . in product evaluation and in packaging.

Purity pays off . . . in rectifiers and diodes having higher peak inverse voltage ratings — in maximum utilization because of uniform lateral and radial profiles over the entire length of the rod. With Dow Corning single crystal rod, you're assured of maximum yield and minimum waste per rod. Rod diameter variation is controlled to less than 1.4 mm (0.055 inches)— simplifying mechanical preparation for either the diffusion or alloying process.

Hyper-pure silicon for every need is now available from Dow Corning. If you grow your own crystals from polycrystalline chunk using the Czochralski method . . . if you zone refine polycrystalline rod . . . if you need 1000-ohm centimeter or better resistivity in single crystal P-type — Dow Corning should be on your preferred source list.

Each Dow Corning single crystal rod is checked for resistivity over its entire length. Resistivity and lifetime profiles, like those shown below, are supplied with each crystal.



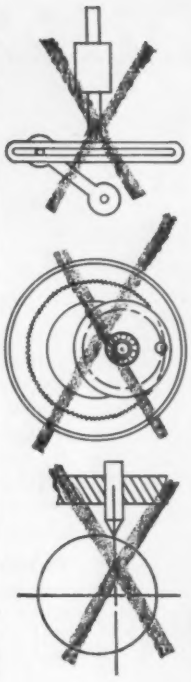


Write for "Hyper-Pure Silicon for Semiconductor Devices." Address Dept. 3514a.

HYPER-PURE SILICON DIVISION
Address: HEMLOCK, MICHIGAN

Dow Corning CORPORATION
MIDLAND, MICHIGAN
ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

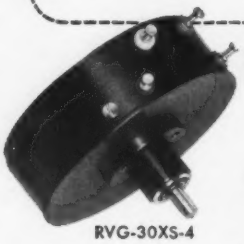
How to keep computers compact



You can often save space, weight and money in equipment employing sine-cosine operations by "designing in" Gamewell Sinusoidal Potentiometers. Far lighter and more compact than gears, cams, and other complicated mechanisms, they're widely used in analog computers, data converters, Tacan systems, and radar components. Advanced design produces functions with smoothness and precision unobtainable by other resistive methods. For details and latest catalog, write THE GAMEWELL COMPANY, 1384 Chestnut Street, Newton Upper Falls 64, Mass. *A Subsidiary of E. W. Bliss Co.*

CONDENSED SPEC OF RVG-30XS-4

Resistance	16,000 ohms ±5%
Conformity	1.0% peak to peak
Starting Torque	0.5 oz. in. max.
Angular Accuracy	±0.7°
Weight	2 oz. max.
Mechanical Rotation	Continuous
Electrical Rotation	360°
Nominal Life	350,000 cycles



RVG-30XS-4

BLISS Gamewell®

PRECISION POTENTIOMETERS

INTEGRALS OF HIGH PERFORMANCE

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Maximum reliability is built into every foot of "Foamax" — Royal's new Foam Dielectric Cable, manufactured to meet highest quality and performance standards. Write for a sample length and technical data.

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For Class B
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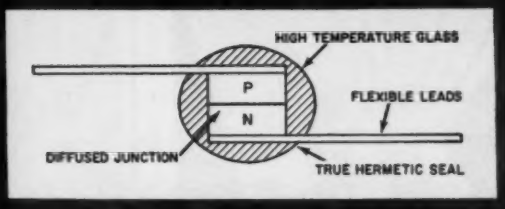
Is your advertising selling the same four key buyers your salesmen call on? Competition demands it! Only advertising in electronics reaches and sells the electronics man *wherever* he is: in *Research, Design, Production, and Management.* Put your advertising where it works *hardest*...

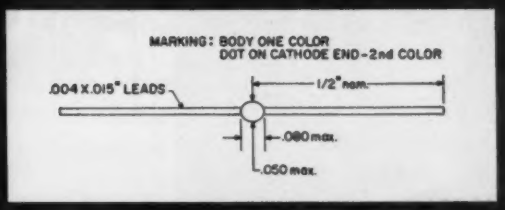
TODAY YOU MUST SELL ALL FOUR!

in **electronics**

ANOTHER FIRST FROM

Transitron





WITH A **TRUE** HERMETIC SEAL

MICRO ZENER DIODES

NO COMPROMISE!

Development by Transitron scientists and engineers of a new concept in glass packaging has now made it possible to introduce the industry's first micro-diode with true hermetic sealing. This is the new micro voltage regulator ("zener") series . . . a series in which the glass is melted *around* the silicon body that forms the working part of the device. Achievement of a direct high-temperature glass-to-metal seal means that there are no plastics . . . no multi-part packaging . . . no "gunk" . . . no degrading of characteristics with humidity. Absolute hermetic sealing makes this the most reliable and efficient micro-regulator ever developed, ideal for voltage regulating and reference service wherever space and weight economies are required.

Micro Zener Diodes are produced exclusively by Transitron. The first series is available immediately; other diodes are under development and will be marketed shortly.

For more information write for Bulletin PB-71E.

SPECIFICATIONS @ 25° C			CURRENT RATINGS	
TYPE	Voltage (1) @ I_Z = 5ma (Volts)	Maximum Dynamic (2) Resistance (ohms)	Maximum Average (3) Operating (ma) Current @ 25° C	@ 100° C
TMD-01*	5.1	15	17.8	4.4
TMD-02	5.6	15	15.5	4.0
TMD-03*	6.2	15	14.5	3.7
TMD-04	6.8	15	13.0	3.3
TMD-05	7.5	15	12.0	3.1
TMD-06	8.2	15	11.0	2.8
TMD-07*	9.1	15	10.0	2.5
TMD-08	10.0	15	9.0	2.3

(1) Voltage tolerance ±10%. For ±5% Voltage Tolerance use "A" suffix (e.g. TMD-03A).

(2) Dynamic Resistance is measured by impressing a small (10% of DC bias) AC current upon the DC Test Current, 5 MADC.

(3) Assume linear derating between 25° C and 100° C.

*Production types

ADDITIONAL CHARACTERISTICS AND RATINGS

Operating and Storage Temperature Range	−55° C to +150° C
Maximum power dissipation at 25° C	100 mW
Typical forward voltage at 5.0 mA	0.75 volt

MEET US AT IRE—BOOTH NOS. 1220-1224

Transitron electronic corporation

wakefield, melrose, boston, mass.

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Many space age customers now benefit from our unique capabilities in R&D and manufacturing. These capabilities stem from years of experience in dealing with the demanding, classical problems in the earth sciences. Our competent staff of 250, and our complete electromechanical manufacturing facilities in our new 60,000 sq. ft. plant are ready to serve you. We invite inquiries concerning your specific problems.

GEOTECH

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"Honest, Ivan, he wasn't spying.
He was going to Texas and his guidance system went haywire!"

Guidance or communications system failures can cause problems! Guard against them with Reeves-Hoffman oscillator reliability. Get the whole story.

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DIVISION OF
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PS/160

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for −100° F to 500° F applications

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CLASS H INSULATION USES: slot lining; interlayer and interphase insulation; harness bundling; splicing; wrapping for microwave components, transformer coils, capacitors and high voltage cables.

NON-STICK USES: non-stick facings for film guides in electronic instruments, heat sealing bars, forming dies, chutes, guide rails, etc.

AVAILABLE FROM STOCK: 1/4″ to 2″ widths, 18 yd. and 36 yd. rolls and 12″ width on liner by lineal yard. Sold through distributors.

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CHR CONNECTICUT HARD RUBBER CO.

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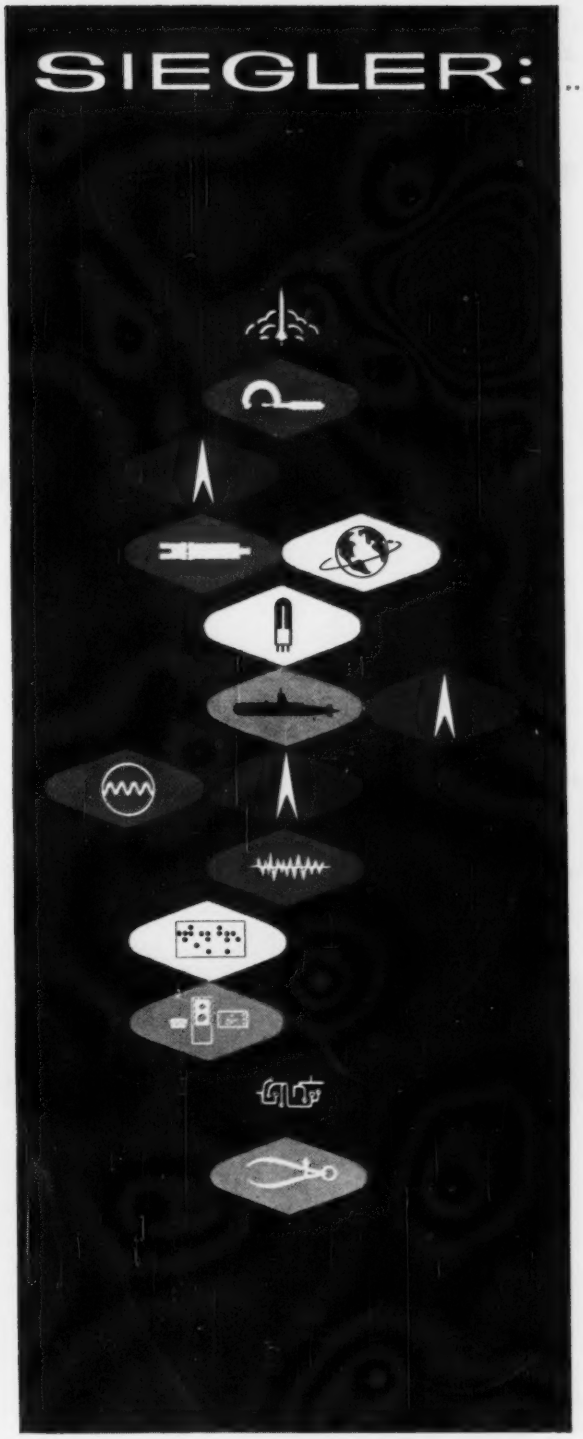

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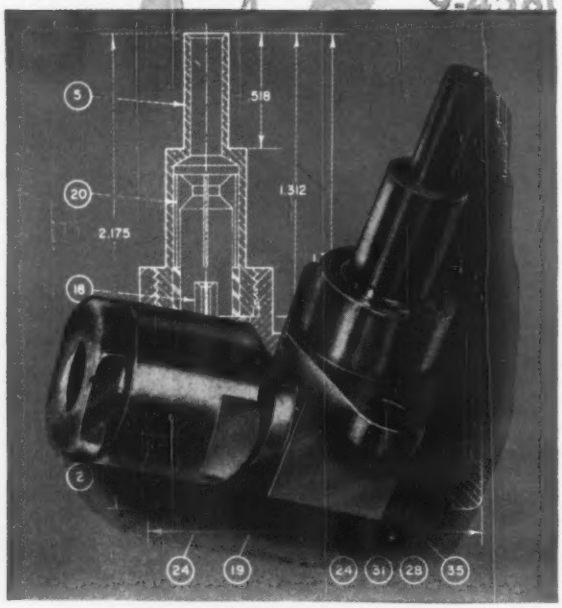

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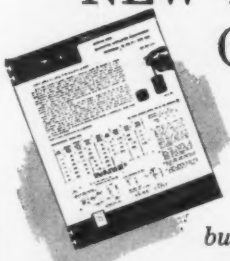

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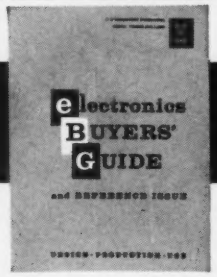

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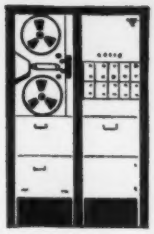

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2N859	40v	150	0.1	30	120	6
2N860	25v	150	0.1	15	45	6.5
2N861	25v	150	0.1	30	100	7.5
2N862	15v	150	0.1	20	60	8
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Self-Adaptive Filter Finds Unknown Signal in Noise

After several occurrences of a random repetitive signal, the automatic system forms a memory of the signal. As the shape of the signal changes, the system alters its memory accordingly and creates an optimum filter

Authors examine waveform generator portion of filter

By C. V. JAKOWATZ and G. M. WHITE, Information Studies Section, Research Laboratory, General Electric Co., Schenectady, N. Y.

THIS ADAPTIVE SYSTEM can detect a random repetitive signal that occurs in a background of additive Gaussian noise. A random repetitive signal is a signal that occurs often, but with random times of occurrence. Originally the system's memory does not contain the shape of the signal it is seeking. However, after several signal occurrences the system is able to both form a representation of the signal in its memory and detect the signal when it occurs. The system is also capable of portraying the likelihood of having the signal in its memory. Furthermore, if the shape of the signal changes slowly with time, the system can alter its representation of the signal. All the operations are automatic and no observer is required for monitoring. The system concepts can be extended to be able to deal with a plurality of different-shaped signals that occur independently of each other in a background of noise.

This article deals primarily with equipment. Further technical discussion is available.[1, 2, 3] Assume that the signal and noise are limited to a bandwidth of $-W$ to $+W$ cycles per second.

Only rough bounds are known about the signal length and the statistics of the signal occurrence. Nothing is known about the shape of the signal. Limiting the bandwidth of the signal and noise allows these waveforms to be represented by sample voltages $1/2W$ seconds apart.[4] Thus, a representative waveform T seconds long can be represented by a vector in $n = 2TW$ dimensional space where the component values of the vector are the voltage samples. Similarly n voltages stored in memory may be considered a waveform.

The description of waveforms as vectors aids in describing the operation that the filter performs in determining the closeness of the incoming waveform with the waveform in memory. This measure of closeness is the cross-correlation function. If the input waveform is represented by a vector **X** and the memory is a vector **M**, then this criterion of closeness corresponds to the dot product **X·M**.

The dot product exceeding a variable threshold value usually indicates that the input is similar to the stored waveform. The input is then averaged in a weighted sense with the stored waveform, so that statistically the stored waveform represents more closely the signal sought. The changing memory is one of the essential adaptive features of the system.

Figure 1A shows the self-adapting filter. Capacitors C_1, C_2—C_n attached to the taps of the delay line serve as a temporary store for the input, since the delay line gives, at an instant of time, the sampled

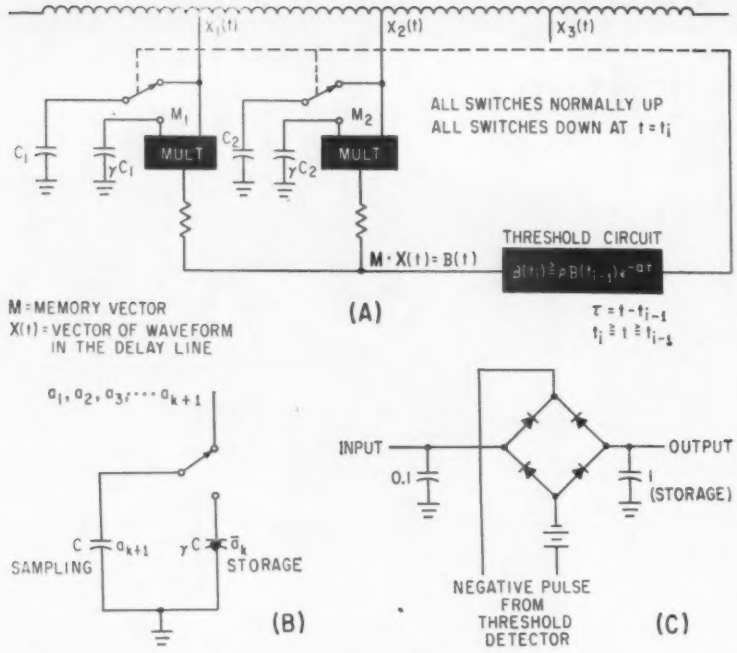

FIG. 1—Operational diagram of self-adaptive filter (A), circuit for weighted averaging (B) and arithmetical switch (C)

values of the incoming waveform. Capacitors $\gamma C_1, \gamma C_2, \ldots \gamma C_n$ retain the sample values of the memory vector.

Each of the multipliers in Fig. 1A has one input channel connected to one of the taps of the delay, while the other input channel is connected to the corresponding capacitor. The products from the multipliers are combined in a summing circuit whose output is then the dot product $\mathbf{X \cdot M}$ at any instant of time. Thus, the delay line, storage capacitors, multipliers and summing circuit compute the correlation function.

A unique feature of the system is the threshold circuit. This circuit operates as follows: If the dot product $\beta(t) = \mathbf{M \cdot X}$ passes through a maximum that is greater than a fraction, ρ, of a previous time weighted maximum, the system alters its memory. Such times are designated as $t = t_i$. The relationship

$$\beta(t) \geq \rho\beta(t_{i-1})\, e^{-\alpha\tau} \qquad (1)$$

is continuously examined where τ is a time variable such that $\tau = t - t_{i-1}$ for $t_i \geq t \geq t_{i-1}$

At the time $t = t_i$ each component of memory is altered to a new value, so that the new representation in memory is

$$M(t_i) = \frac{\gamma \mathbf{M}(t_{i-1})\, e^{-\delta\tau} + \mathbf{X}(t_i)}{\gamma + 1} \qquad (2)$$

where γ is a constant weight factor and δ is a forgetting factor, determined by the time constants of the memory capacitors.

The weighted averaging was achieved in the original version of the system by the two capacitor systems shown in Fig. 1B. If the voltage $\bar{a}_{k-1}$ is on the storage capacitor and a_k is on the sampling capacitor, then after the closure of the relay, the voltage $\bar{a}_k$ appears on the storage capacitor, where

$$\bar{a}_k = \frac{\gamma \bar{a}_{k-1} + a_k}{\gamma + 1} \qquad (3)$$

Relationship in Eq. 3 exists because the charges are brought to equilibrium. If the past values on the sampling capacitor were $a_1, a_2 \ldots a_{k-1}$, the value of $\bar{a}_k$ becomes

$$\bar{a}_k = \frac{a_1}{\gamma}\left(\frac{\gamma}{\gamma+1}\right)^k + \frac{a_2}{\gamma}\left(\frac{\gamma}{\gamma+1}\right)^{k-1} \cdots \frac{a_k}{\gamma}\left(\frac{\gamma}{\gamma+1}\right) \qquad (4)$$

after the kth closure.

This relationship indicates that the more recent samples transferred to the storage capacitor are weighted heavier than the past ones. Thus, γ, the ratio of the capacitors, determines how heavily the past events are weighted. In a modified version of the system, the diode ring switch shown in Fig. 1C accomplishes the same type of switching.

The multipliers used in Fig. 1A are standard commercial analog four-quadrant multipliers. Due to the cost of these multipliers and their bandwidth limitations, some thought was given to performing the correlation computation by quantized techniques.[5] These are not discussed here.

Some subsidiary circuits had to be developed to furnish inputs to the system. One of these was a waveform generator capable of furnishing the signals at random times. The shape of the signals is selected by adjusting a set of potentiometers. The circuit for this, using a Burroughs beam switching tube (BST), is shown in Fig. 2A. When the noise from a General Radio noise generator exceeds a given value, a transistorized threshold circuit opens a gate, allowing a sinewave to drive the grids of the BST. The result is that the electron beam steps sequentially through the ten sections of the tube. When it reaches the 9 position, a pulse is fed back, closing the gate. Transistor circuits are attached to the targets of the BST. When the beam rests temporarily on any one of the targets, the emitter circuit of the transistor can pass current and a similar amount of current flows through the collector. The magnitude of this current is controlled by the 25,000-ohm potentiometer; thus the BST stepping through its ten positions causes a sequence of different voltages to appear at the output.

A noise generator supplies the noise used at the input to the system. Noise is added to the signal from the waveform generator in a summing circuit. The sum is applied to the system. Samples of the output waveform with and without noise from the first tap of the delay line are shown in Fig. 2B. The filtering action of the delay line smooths the corners of the output of the waveform generator.

A mechanical switch was also constructed to scan sequentially the output of the storage capacitors once per second. The output

of this switch is recorded on a Sanborn recorder to indicate the memory's representation of the signal.

Experimental data was obtained to determine the convergence time of the system; that is, the time required for a representation of the signal to be stored in the memory. Some of the typical signal waveforms used are shown in Fig. 2B. The post-integration signal-to-noise ratio,

$$R = 2E/N_o \qquad (5)$$

for the signal and noise cases shown was about 10. In Eq. 5, E is the signal energy and N_o is the noise energy per degree of freedom. The duration of the signals was around 7 msec and the average rate of occurrence was 25 pulses per second.

A typical result for one run using the center waveform of Fig. 2B is shown in Fig. 2C. Because of the scanning switch, the contents of memory are printed out once every second. During this time about 25 signals have occurred between scans. The other curve in the figure is the threshold level. This is low prior to the signal being inserted because only noise is being correlated with noise. When the signal is inserted, this level rises. Thus, the level can be used to indicate that a signal is present along with the noise. When the threshold attains its new equilibrium value, the contents of memory also stabilize and represent the signal being sought. If the signal is removed, the threshold level decreases, and the contents of memory become random once more.

The authors thank R. L. Shuey for his many discussions, J. E. Taylor for suggesting the diode switch and R. R. Gilbert for constructing much of the equipment.

REFERENCES

(1) C. V. Jakowatz, R. L. Shuey, G. M. White, Adaptive Waveform Recognition, GE Research Laboratory Report No. 60-RL-2353E Feb. 1960.
(2) C. V. Jakowatz, R. L. Shuey, G. M. White, Adaptive Waveform Recognition, GE Research Laboratory Report No. 60-RL-2435E, May 1960.
(3) C. V. Jakowatz, R. L. Shuey, G. M. White, Adaptive Waveform Recognition, presented at the Fourth London Symposium on Information Theory, Sept. 1960.
(4) C. E. Shannon, Communication in the Presence of Noise, *Proc IRE* 37, 1949.
(5) G. M. White, Quantized Adaptive Filter, GE Research Laboratory Report No. 59-RL-2287E, Oct. 1959.

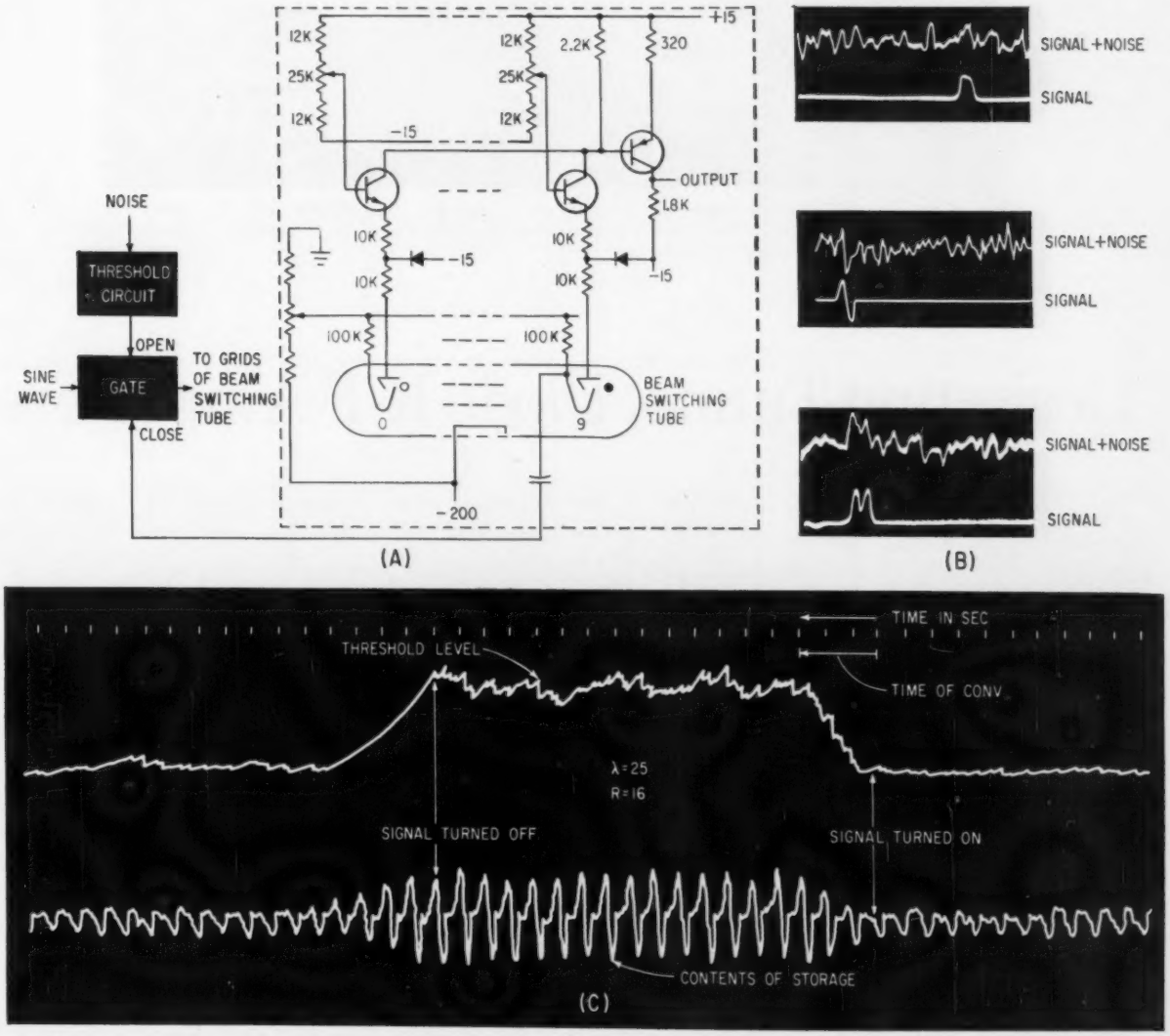

FIG. 2—Waveform generator (A), typical inputs (B) and filter output (C)

Etched stripline filter being inspected prior to final assembly. The tunnel diode amplifier and the stripline shorted quarter-wave bandpass filter are combined in a single module to provide an extremely rugged and reliable assembly

Designing Tunnel Diode R-F Amplifiers

By EARL D. LONG,
CHARLES P. WOMACK,
Wilcox Electric Company Inc.,
Kansas City, Missouri

MINIATURIZATION of r-f circuits is one of the most active areas of development. High frequency transistors are becoming widely used as r-f amplifiers, but for low signal levels, noise becomes a problem. Selective r-f circuits using conventional air coils and fixed capacitors are of an established size for a required response curve and insertion loss and cannot be appreciably reduced in size. Stripline techniques[1, 2] have shown promise in reducing the size of tuned circuits at microwave frequencies. At present the tunnel diode[3, 4, 5] is showing promise as a low-noise, low-level r-f amplifier. A combination of stripline filters and a tunnel-diode amplifier appears to offer the advantages of low-noise r-f amplification in the uhf region, good filter selectivity with small size, reliability due to rugged packaging, and reproducibility and low cost.

Design requirements were established for a receiver front end that would be reliable, stable, light, small, and reproducible in large quantities at a minimum cost. The receiver center frequency is 330 Mc. The front end selectivity requirements called for a loaded Q of approximately 40 and a nominal midband insertion loss. Also, no more than ± 0.5 percent center frequency variation is allowed over all environmental extremes. To provide isolation between varying antenna impedances and the tunnel-diode amplifier, a midband insertion loss of 5 db was intentionally incorporated in the filter design. The front end must also have approximately 6 db of insertion gain at the design frequency with a minimum noise figure.

The selective r-f amplifier was designed for use in a miniaturized airborne receiver.

The initial step was the development of a filter. Preliminary filter design indicated that the selectivity requirements could be met with four high-Q resonators coupled to form a maximally flat bandpass filter. The bandpass prototype is shown in Fig. 1A.

The half-power bandwidth of 10 Mc is sufficiently broad to tolerate the frequency drift from tempera-

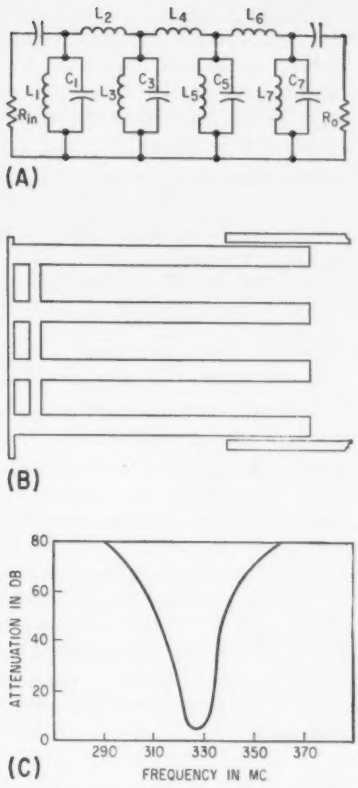

FIG. 1—The prototype bandpass filter at (A) uses shorted quarter-wave arrangement shown in (B) with characteristics shown in (C)

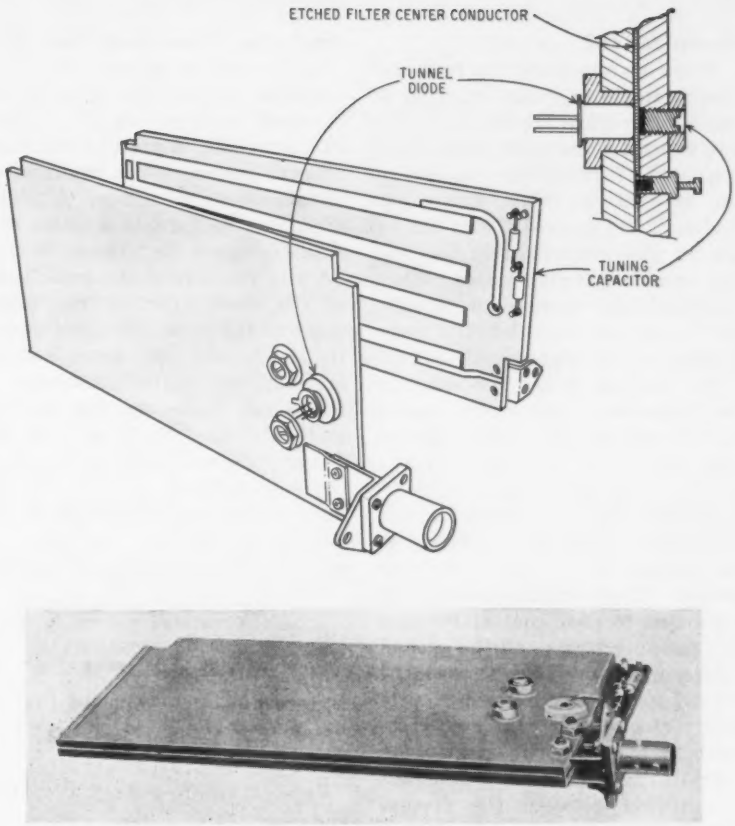

FIG. 2—Complete filter and r-f module showing internal layout of coupling and tuning arrangement

Stripline techniques coupled with a tunnel-diode amplifier make a miniaturized r-f amplifier having a stable insertion gain of 25 db and a theoretical noise figure of 2.7

ture and humidity variations, so no method of reducing drift was considered. Three filter configurations were investigated: the end-coupled stripline resonator filter[6] with elements an integral number of half wave-lengths long, parallel-coupled stripline resonators[7] each a half-wavelength long and shorted quarter-wavelength resonators coupled using the arrangement in Fig. 1B.

Initially the end-coupled stripline resonator filter was selected because it appeared to offer the best possibilities of obtaining high unloaded Q and was easily constructed from strip transmission line. However, since space and weight reduction are important in the application, a reduction in size was mandatory. Attempts were made to accommodate the elements of the filter in a relatively small space by forming the transmission line into a spiral. This reduced size, but only at the expense of lowering the maximum obtainable Q's of the resonators. Consequently, the end-coupled resonator filter was rejected.

The parallel-coupled resonator filter is desirable for narrow-band filter design because of the relaxed tolerances on the coupling gaps between elements. In addition, the overall length of the filter is reduced to half the total length of the end-coupled resonator filter. However, since available length is slightly less than 7 inches, and because the elements of the parallel-coupled resonator filter do not adapt easily to bending, it in turn was rejected.

The shorted quarter-wavelength filter was decided upon because it seemed to offer the best possibilities for controlling the tolerances of the desired response and because it could easily be adapted to the geometry of the available copper-clad laminate.

The layout of the filter is shown in Fig. 2. Resonators a quarter-wavelength long are shorted to the two ground planes that are separated by a Teflon Fiberglas dielectric. For filters requiring high loaded Q-factors and small insertion loss in the microwave spectrum, an air-dielectric is recommended. In the present case size is an important consideration and the loaded Q-factor is not exceptionally large, consequently, a low-loss Teflon impregnated Fiberglas dielectric was

chosen for the assembly.

Work on the filter involved several attempts to obtain shorting of the quarter-wave resonators to the two ground planes. One such effort consisted of grounding one end of the resonators using rivets and solder. Tests showed Q's of 126 or less; it was concluded that this was due to side fringing losses. When two rivets per resonator were used, the measured unloaded Q's were higher, but not significantly so.

The method chosen for shorting the resonators to the ground planes was to use a silver paint spread over and about the ends of the resonators and ground planes. Measurements indicated much higher unloaded Q's than before; however, the values were not consistent enough. These erratic results were attributed to poor contact between the clamping rivets and the ground planes, and to pressure between the ground planes that tended to produce tilting. By switching to a cement to hold the two copper-clad laminates together, and thus eliminate tilting between the ground planes, measurements gave more consistent results.

Since some tolerances, such as dielectric constant of laminate and ground-plane spacing, could not be maintained, a method was required for realizing exact center frequency filters. Dielectric tuning was initially decided upon, but because of fabrication difficulties, it was discarded in favor of capacitive tuning screws in one ground plane at the high electric field region of the two center resonators. Tests indicated a two-percent shift in the center frequency with the tuning screws located about 0.020-in. from the center conductor.

The maximum tuning range is restricted because of the lowering of the loaded Q, which shows about a ten-percent decrease from the design value. Figure 1C shows a comparison between the measured insertion loss of the filter and the exact theoretical curve for the stripline network computed for a center frequency of 330 Mc and neglecting dissipation.

A tunnel-diode amplifier is required to provide approximately 6-db stable insertion gain at 330 Mc and in addition must possess a minimum noise figure. The basic property[5] of a tunnel diode that allows it to be used as an amplifier is it's negative resistance region in the forward voltage versus current characteristic. A positive resistance absorbs power, but a negative resistance delivers power. A tunnel diode can be used as a shunt or a series element as shown in Fig. 3A and 3B. Due to the capacitance of the diode junction, the inductance of the leads, the resistance of the leads and the semiconductor material, the equivalent circuit of the tunnel diode may be approximated by the circuit of Fig. 3C. Using this equivalent circuit with the parallel diode of Fig. 3A, the amplifier can be represented by the circuit of Fig. 3D. The insertion gain for this network is defined as:

$$G_i = \frac{\text{Power delivered to load with network inserted}}{\text{Power to the load with the network removed}} \quad (1)$$

In terms of the network of Fig. 3D

$$G_i = 1/|1 + R_T Y_D|^2 \quad (2)$$

Where

$$R_T = (R_g R_L)/(R_g + R_L) \quad (3A)$$

and

$$Y_D = g_D + jb_D \quad (3B)$$

The real and imaginary terms of Eqs. 3B are

$$g_D = [(R_s - R_d + \omega^2 R_d L_s C_d) - \omega^2 R_d C_d (L_s - R_d R_s C_d)]/[(R_s - R_d + \omega^2 R_d L_s C_d)^2 + \omega^2 (L_s - R_d R_s C_d)^2] \quad (4A)$$

$$b_D = \omega[(R_d R_s C_d - L_s) - R_d C_d (R_s - R_d + \omega^2 R_d L_s C_d)][(R_s - R_d + \omega^2 R_d L_s C_d)^2 + \omega^2 (L_s - R_d R_s C_d)^2] \quad (4B)$$

Analysis of this circuit requires the following conditions for stable amplification

$$R_T > L_s/(C_d |R_d|) \quad (5A)$$

$$|R_d| > R_T \quad (5B)$$

Additional design requirements of the amplifier are that the input and output impedances are 50 ohms resistive. The 1N2939 germanium tunnel diode is suitable for this application. The negative resistance portion of the forward V-I curve has a slope of approximately 133 ohms. The diode has approximately 5pF of capacitance, lead inductance of approximately 10 nanohenries and a series resistance of approximately 1 ohm.

A good bias point is about 140 mv and 0.7 ma. The conditions for stability can be used to determine the limits for the a-c load line and are plotted in Fig. 3E. The circuit parameters can now be calculated. As a first step, set the reactive part of Eq. 4 equal to zero, and the real part equal to some fixed value $-1/R$. Now

$$g_D = -1/R = [(R_s - R_d + \omega_0^2 R_d L_s C_d) - \omega_0^2 R_d C_d (L_s - R_d R_s C_d)]/[(R_s - R_d + \omega_0^2 R_d L_s C_d)^2 + \omega_0^2 (L_s - R_d R_s C_d)^2] \quad (6A)$$

$$b_D = 0 = \omega_0[(R_d R_s C_d - L_s) - R_d C_d (R_s - R_d + \omega_0^2 R_d L_s C_d)]/[(R_s - R_d + \omega_0^2 R_d L_s C_d)^2 + \omega_0^2 (L_s - R_d R_s C_d)^2] \quad (6B)$$

Solution of the expressions for L_d and $-R$ gives

$$-R = R_s - R_d/(1 + \omega_0^2 R_d^2 C_d^2) \quad (7A)$$

$$L_d = R_d^2 C_d/1 + \omega_0^2 R_d^2 C_d^2 \quad (7B)$$

Typical parameters for tunnel diode type 1N2939 are $C_d = 5 \times 10^{-12}$ farads, $R_d = -133$ ohms and $L_s = 10 \times 10^{-9}$ henries.

Using these parameters, evaluation of Eq. 7B gives for the series diode inductance $L_d = 28 \times 10^{-9}$ henries. Consequently an additional 18 nanohenries is required. Equations 7 may be rearranged to yield an expression for R_s in terms of L_d, C_d, R_d and R. This yields

$$R_s = (L_d/C_d R_d) - R \quad (8)$$

and upon evaluation R_s is 17 ohms for a value of R equal to 25 ohms. This value of R was chosen to give infinite gain.

The series diode resistance is approximately 1 ohm. Hence, to give the above value for R_s, 16 ohms of resistance must be added in series with the diode. This additional resistance may be divided between the internal impedance of the bias supply and a series resistor.

Examination of the V-I curves (Fig. 3E) shows that if a d-c current source is used to obtain the 0.7 ma of bias current required, there are three voltages that satisfy this requirement. Since the negative resistance region is more unstable than the positive resistance regions, the Q-point of a tunnel diode biased from a constant current source will rest at point 1 or 3, but not 2. In this case the diode functions as a switch. To hold the Q point at 2, the bias must be set by a constant voltage source of low internal impedance. It was found that a voltage source with 6.8 ohms internal impedance performs satisfactorily. The complete practical circuit is shown in Fig. 3F.

The theoretical noise figure[6] for a tunnel diode amplifier has been

derived and has as its theoretical lower bound

$$F \geq 1 + \frac{I_o R}{2kT_o/q} \cdot \frac{\omega_c}{\omega_c - 2\omega} + \frac{T_d}{T_0} \cdot \frac{2\omega}{\omega_c - 2\omega}$$

where NF = noise figure (a power ratio), I_o = steady state diode current (amperes), R = diode resistance (absolute magnitude in ohms), T_o = Ambient temperature in degrees Kelvin, k = Boltzmann's constant 1.37×10^{-23} (joule per degree K), T_{d_0} = diode temperature electronic charge (degrees K), ω = operating frequency (radians/sec) and ω_d = diode cutoff frequency = $1/R_sC_d$ (radians per sec). For the amplifier, the lowest possible theoretical noise figure is 2.7.

One version of the amplifier was fabricated on a through stripline. The gain of the amplifier was controlled by a variable capacitor from the anode to ground. It was found that almost any insertion gain up to the point of oscillation (infinite gain) could be obtained. Stable insertion gains of 25 db were easily obtained. A gain of 10 db was finally chosen as an optimum value.

The final version of the tunnel diode amplifier was fabricated on the same board as the stripline filter (see Fig. 2). Capacitive coupling was used to couple signal from the filter to the tunnel diode amplifier. An output transmission line was used between the filter impedance of 50 ohms and the mixer input, which is approximately 60 ohms. Thus the impedance at any point along the transmission line is nearly 50 ohms.

Several methods of holding or clamping the tunnel diode and its circuit were used. It was found that the capacitance of the holder must be small, approximately 1 picofarad, and the bias circuit must be isolated from the a-c circuit. A low-capacitance holder was made from a nylon bushing and installed in the stripline material so that the tunnel diode (cathode) makes contact with the center conductor of the output transmission line.

The remaining circuit of the r-f amplifier was mounted on the end of the filter. Amplified signal is coupled from the output transmission line to the mixer by means of a rivet attached to the line and a low inductance pressure contact connected to the mixer input capacitance. The mixer input capacitor is series resonant at the center frequency with its leads and the pressure contact. A series L-C circuit, tuned capacitively to resonate at 270 Mc, is connected from the mixer base to ground. These two circuits provide isolation between the local oscillator injection frequency of 270 Mc and the tunnel-diode amplifier.

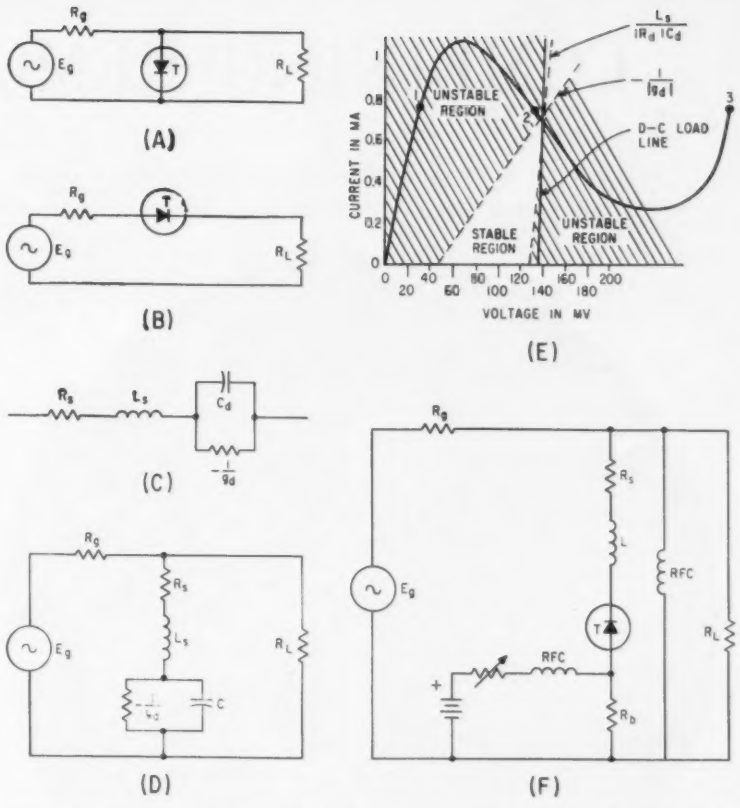

FIG. 3—Shunt amplifier (A) and series amplifier (B). Tunnel diode equivalent circuit (C) and equivalent shunt tunnel diode amplifier (D). Limit of a-c load line stability (E) and equivalent circuit of shunt tunnel diode amplifier showing bias circuit (F)

Photoetch techniques are used for both the stripline filter and tunnel diode amplifier. The etched boards are cemented together using epoxy cement. This forms a reliable assembly that is impervious to temperature, humidity, altitude, and mechanical vibration and shock. The tunnel diode and other components are rigidly held, accessible and easily replaced. The front panel connector is attached to the stripline and the entire assembly slides into place in the receiver. Only three connections are then made to the assembly; the bias supply for the tunnel diode, and the rf input and output connections.

The authors thank T. Channel for his contributing ideas and T. Reed who constructed the modules and provided the experimental data.

REFERENCES

(1) E. H. Bradley, Design and Development of Strip-Line Filters, *IRE Trans*, MTT-4, April 1956.
(2) E. G. Fubini, W. E. Fromm, and H. S. Keen, New Techniques for High-Q Strip Components, *Conv Rec IRE*, **8**, 1954.
(3) C. D. Todd, Tunnel Diode Applications, Publication of Hughes Semiconductor Div, Newport Beach, California, Feb. 1960.
(4) U. S. Davidsohn, Y. C. Hwang, and G. B. Ober, Designing with Tunnel Diodes, *Electronic Design*, Feb. 3 and Feb. 17, 1960.
(5) I. A. Lesk, N. Holonyak Jr., and U. S. Davidsohn The Tunnel Diode-Circuits and Applications, ELECTRONICS, p 60, Nov. 27, 1959.
(6) S. B. Cohn, Direct-Coupled-Resonator Filters, *Proc IRE*, **45**, Feb. 1957.
(7) S. B. Cohn, Parallel-Coupled Transmission-Line-Resonator Filters, *Proc IRE*, MTT-6, April 1956.
(8) M. E. Hines, High-Frequency Negative-Resistance Circuit Principles for Esaki Diode Applications, BSTJ, **39**, 3, May 1960.
(9) P. Penfield Jr., Noise Performance of Tunnel-Diode Amplifiers, *Proc IRE*, **48**, 8, Aug. 1960.

COMBINING REMOTE RADARS

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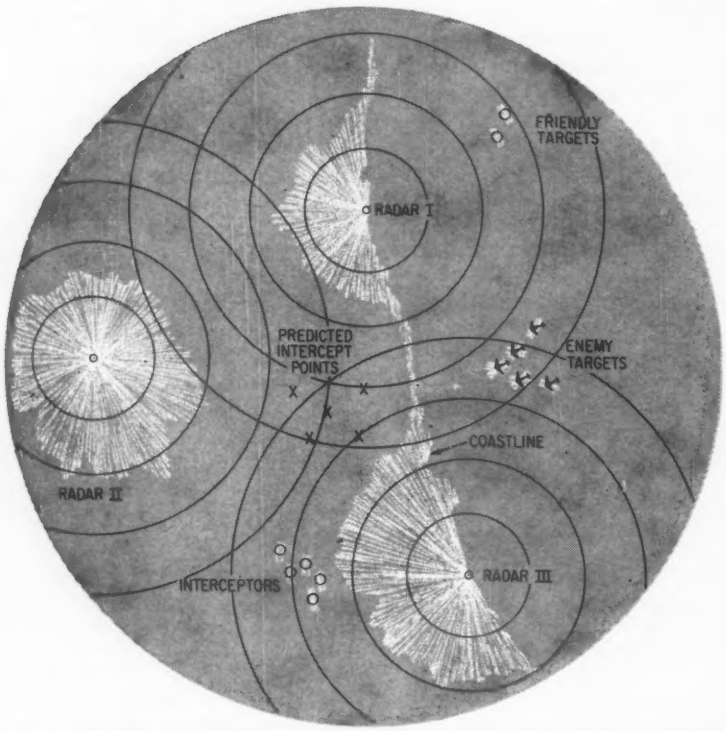

FIG. 1—PPI shows the signals from three radars as a single map, with two sets of video return where radars overlap. Each radar has a sweep on the ppi tube to represent the position of its own antenna

IT IS IMPORTANT for the principal operators of a ground-control radar system to be able to see the entire area covered by the system. For a system using just one radar installation, the easiest way to provide the operator with an overall view is to use a conventional ppi display. However, in covering a larger area information must be collected from several radars, and it is not ordinarily possible to provide an overall display of multiple radar information on a single-gun ppi scope. This article describes a system, which, using an auxiliary storage and synchronizing unit, combines video information from three radars for display on a single-gun ppi scope. This system uses about 40 percent of the total display cycle for superimposing auxiliary information on the same display.

The main problem in displaying multiple radar information is caused by repetition rate and radar synchronization limitations. A radar with a pulse-repetition-frequency of 333 cps is pulse-rate limited to a range corresponding to 3,000 microseconds or approximately 240 miles, neglecting the time required for sweep recovery. It would be possible, but highly impractical, to synchronize two radars having this pulse-repetition-frequency and then to display approximately 100 miles of range from each radar on a combined display. The problem of display time is further complicated by the usual need for superimposing auxiliary information such as target and interceptor track position and intercept points on the radar display.

Insufficient time between radar transmission and reception for displaying desired information is not a new problem and numerous schemes have been used with varying success, some of which are shown in the editorial box.

The display system described in this article solves the problem of simultaneous presentation of in-

METHODS OF COMBINING INFORMATION FROM SEVERAL RADAR SYSTEMS

Plotting Board—Information derived from individual radar ppi's may be combined manually or automatically on a master plotting board. This method of data presentation is slow and cumbersome, and is difficult to read accurately with speed.

Multiple-Gun Cathode-Ray Tube—Using a separate gun for each radar set and a gun or guns for auxiliary information, it is easy to combine the information in a single cathode-ray tube. This method has the inherent inaccuracy of tracking errors between guns and is expensive when several displays are needed.

Optical Combining—Information from several cathode-ray tubes may be optically combined onto a single composite display. This method is simple in theory, but difficult mechanically and relatively inaccurate, even when carefully done.

Artificial Display—By converting the radar returns to positional data, the desired information may be put onto a combined display. This technique has the disadvantages of the possibility of saturation and of not permitting the operator to see the raw radar video

ON A CENTRAL DISPLAY

Information from outlying radars is organized into a single map spanning the territory of all radars in the system. Each radar is represented by its own separate sweep on the ppi, with this sweep reproducing the antenna position of its radar

formation from several radars by electronically combining video signals from these radars at a central point then displaying them all on one ppi tube. In addition to the large-area radar map that results, auxiliary information about operating conditions, aircraft location and so on can be presented as brightened 100-microsecond pulses that are positioned electronically on the ppi in the desired locations.

Figure 1 is a diagram of the resultant presentation, which uses separate rotating traces for each of three radars that the system embraces. These range sweeps, although seen simultaneously by the operator because of fluorescent and visual persistence, actually occur in time-sequence, with three such sweeps followed by two equal periods of auxiliary information display.

The prf of the combined system is 200, thereby dividing the operational sequence into subcycle intervals of 5,000 microseconds. Each sweep is allotted 1,000 microseconds, and since three sweeps occur in sequence, 2,000 microseconds is available in each subcycle for presentation of auxiliary information. Auxiliary information is in the form of 100 microsecond pulses, and 20 such pulses can be sandwiched into every subcycle, between one set of sweeps and the beginning of the next.

To increase the number of auxiliary pulses that can be displayed, the auxiliary information is spread by a time-sharing process into four sets of 20 pulses over four subcycles as shown in Fig. 2, permitting 80 information points to be presented in a 20,000 microsecond period.

It is not possible to synchronize the centralized ppi display with the triggering of outlying radars, so occasions will arise when information from an outlying station arrives at the control center at the same time as the memory is being read out, and its content displayed on the ppi. Since the Radechon storage tube cannot simultaneously store and provide readout functions, a second memory tube covers these overlapping requirements. The two memories which are provided for each radar, alternate between storage and readout functions, thereby ensuring that one or the other memory is always free to receive fresh information.

Added flexibility of operation is provided at the central control station by providing several ppi tubes, each with its own operator, who can specialize on a particular facet of the control operation.

By switching in only the lines associated with the signal he desires to view, each operator may limit his individual display to any combination of radars, or combine the information from selected radars with particular categories of auxiliary information.

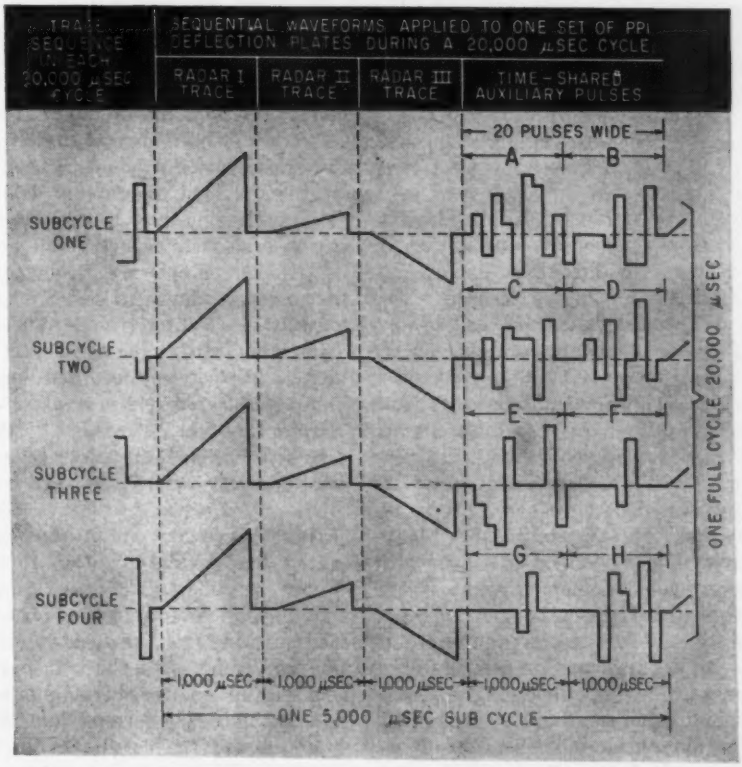

FIG. 2—Time sharing of the auxiliary information requires four subcycles in which to sandwich all of the possible 80 information pulses, each of which are 100-microsecond duration. The three sweeps in each subcycle position the traces in accordance with the antenna position of the radar they represent

Kerr magneto-optic system consists of parallel light source, polarizer, sample holder, analyzer and camera

Patterns in Thin Films Make Fast Nondestructive Memories

Studies of domain behavior by the Kerr optic method show that irreversible domains can be formed in thin magnetic films. This concept can be the basis of a nondestructive memory capable of operating at rates exceeding 10 Mc

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GROWING INTEREST in thin films for memory elements has prompted the need for studying the domain patterns in thin magnetic films.

The domain pattern at the surface of a magnetic film can be visually observed by the Kerr optic effect. The Kerr effect results from the rotation, through different angles, of plane-polarized light corresponding to the magnetic state at the surface where the light is reflected. The system permits photographing a domain pattern with sharply defined domain walls, where light areas represent one remanent state and the dark areas the other.

Binary information can be stored on a thin film by causing a single domain to be formed throughout the film through application of orthogonal fields. These fields are usually generated by two conductors perpendicular to each other close to the film. One conductor is parallel to the easy direction of magnetization, and the other is parallel to the hard direction. An irreversible domain of opposite state is then formed inside this domain by application and removal of a transverse field over a small area.

If a film sample is initially magnetized completely in one state, it constitutes a single large domain. This domain is stable as long as no external field is applied. But applying a transverse field to a restricted narrow region of this domain causes the dipoles in this region to rotate toward the hard direction. Removal of this transverse field leaves the dipoles in an unstable state. The demagnetization forces of the neighboring domains cause the dipoles to rotate to the opposite magnetic state. Repeated application and removal of the transverse field will not change the magnetization of this newly formed domain.

A study of the domain behavior under various wiring configurations has shown that a narrow region of either state may be formed. At the center of this narrow region, an irreversible domain of opposite state may be formed.

The usefulness of this arrangement as a nondestructive memory element has been confirmed by pulse tests. Nondestructive readout sense signals up to 30 mv and of opposite polarity for both 1 and 0 have been observed. The output amplitude is a function of pulse rise time and the size of the irreversible area.

The Kerr magneto-optic system used in these experiments is shown in the photograph. The polarized light shines on the film sample at an incident angle of 58 deg; the plane of polarization is parallel to the film's hard direction. The reflected light passes through the analyzer and the objective of the camera.

The film samples are mounted face down, so that the light from the polarizer first hits the glass substrate and then the film. This allows conductors to be placed on the other side close to the film. The polarized light is rotated clockwise if the film is in the *P* state (see

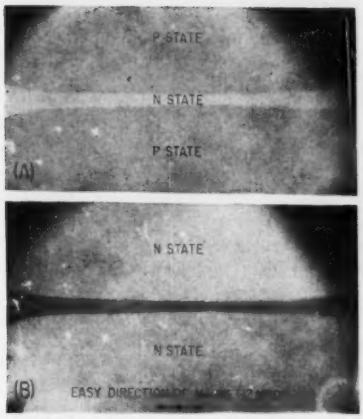


FIG. 1—Formation of N state (A) and P state (B) irreversible domains by a transverse field

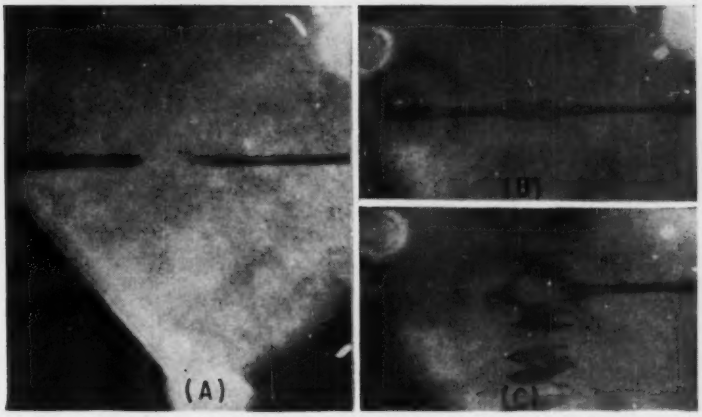


FIG. 2—Discontinuity with 0.4-amp parallel field (A). With polarity reversed, bulge increases as parallel current is increased from 0.25 amp (B) to 1 amp (C)

box) and counterclockwise if in the *N* state. The *P* state will appear dark and the *N* state light.

The film was magnetized into one state by a magnet. When a transverse field was applied and removed, a domain of opposite state appeared, having the shape of the transverse drive conductor. When the current in this conductor was 300 ma, the width of this new domain measured 0.01 in. At one ampere it measured 0.026 in. The domain widened linearly with the current up to two amperes. Figure 1 shows a domain pattern obtained with a transverse current of one ampere. A current of up to 400 ma in the two conductors generating a field in the easy direction (parallel field) does not cause any remagnetization. But if this current is applied in coincidence with the transverse field it will influence the shape of the new domain. The transverse field is always removed ahead of the parallel field.

In Fig. 2A, the film was initially magnetized to the *N* state. Orthogonal fields were applied and removed; with the parallel field in the *N* direction, a discontinuity appeared where the conductors intersected. The discontinuity increased with the parallel current.

In Fig. 2B, the polarity of the parallel current was reversed (*P* direction), and a bulge appeared at the conductor intersection. Again, increasing parallel currents increased the size of this bulge, as shown in Fig. 2C. When the parallel field reaches the coercive force of the film, remagnetization occurs by domain wall movement, and walls appear at angles of 45 deg. The demagnetizing field causes a breakup of this domain into island domains when the external fields are removed. These island domains are longer in the preferred direction.

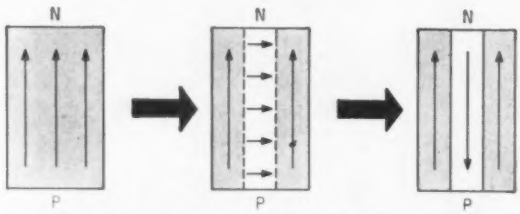
Figure 3A shows a film initially magnetized to the *N* state. A transverse field is applied and removed, forming the irreversible *P* domain shown in Fig. 3B. Next, orthogonal fields are applied and removed, with the parallel field in the *N* direction. A discontinuity now appears where the *N* state is written onto the film.

To read this state nondestructively, an irreversible domain must be formed across the region. If a transverse field alone is applied and removed, the dipoles will rotate toward 90 deg. Demagnetizing fields of surrounding domains act to deflect these dipoles toward the opposite state, where they go when the transverse field is removed. Now an irreversible *P*-state domain is formed across the center of a region that was formerly *N* state. This pattern is shown in Fig. 3D.

With the pattern of Fig. 3D as initial condition, write a *P*-state domain that can be read nondestructively. This can be accomplished by again applying orthogonal fields, the parallel field acting toward the *P* state. The transverse field causes the dipoles next to the conductor to rotate toward 90 deg. To either side of the transverse drive conductor a gradient field exists where the field is decreasing as the distance from the conductor increases. This places a bias field on all dipoles within this region. When the parallel field is applied, all dipoles at 90 deg are deflected toward the *P* state. Many of the dipoles that were biased by the transverse field are now rotated past 90 deg toward the *P* state. These dipoles contribute to the bulge in Fig. 3E.

To read the *P* state of Fig. 3E nondestructively, an irreversible domain of opposite state must be formed across this region. If a transverse field is now applied and removed, dipoles in the central part of the bulge will rotate toward 90 deg. Demagnetizing forces due to the *P* state domain will deflect the dipoles past 90 deg toward the *N* state where they fall when the transverse field is removed. An irreversible *N*-state domain is formed across the center of the *P*-state bulge-shaped domain. This is illustrated in Fig. 3F.

Figure 3 illustrates the principle of a nondestructive memory. A memory bit will be located at the intersection of the orthogonal conductors. Either *N* or *P* states may be written into this location by applying orthogonal fields. The field amplitude in the easy direction should be less than H_c and the transverse field greater than H_k. The location must then be primed—which means an irreversible domain must be formed. This is done by applying a single pulse to the transverse field. The location is now ready for nondestructive readout. Every time a transverse field is applied, a rotation in the same direction will occur. Similar pulses could be induced on a sense line.



Formation of an irreversible domain surrounded by domains of opposite state is applicable to nondestructive memories

THEORY

The switching mechanism of magnetic films, of which the thickness is about 2,000 angstroms, is predominantly spin-rotational. The magnetic films used in these studies are composed of 81 percent nickel and 19 percent iron, vacuum-deposited on glass substrates 40 mils thick.

These films possess a preferred direction of magnetization, sometimes called the easy direction. B-H curves plotted with the field applied in the easy direction are rectangular. The direction perpendicular to the preferred direction is defined as the hard direction of magnetization. B-H curves plotted in this direction are linear.

Plots of the B-H curves, with a resultant applied field at angles between 0 and 90 deg, will generate a family of curves that vary from linear to rectangular, depending upon the angle. These intermediate curves are known as sheared loops. The essential measurable characteristics of the thin films are: H_c, a measure of the coercivity of the rectangular loop, and H_k, the saturating magnetization field in the hard direction evaluated from the linear loop. Films used had $H_c = 0.9$ oersted and $H_k = 1.5$ oersteds.

The anisotropy properties keep the magnetization vector (M) parallel to the preferred direction. This position corresponds to the minimum anisotropic energy condition, and to the maximum value of anisotropic field. Should the M vector be rotated 90 deg, it will pass through a gradient where the anisotropic energy increases to its maximum value and the anisotropic field decreases to zero.

The demagnetizing field originates from the dipoles within a domain. A mmf exists across the ends of this domain, causing the demagnetizing field to act opposite to the direction of magnetization. The demagnetizing field at any point on the surface of a thin film depends upon the domain pattern surrounding this point. The demagnetizing field is usually assumed to act parallel to the preferred direction, in the plane of the film, when all dipoles are parallel or antiparallel to the preferred direction.

Rotation of the M vector to a 90-deg position requires that an external field be applied. This field (the transverse field) is applied in the hard direction of magnetization. Its amplitude must be greater than H_k. If the transverse field is localized to a small region of the film, the dipoles in this region rotate to the hard direction, forming a 90-deg wall. But this is only partly true, since the surrounding dipoles, which are not moved by the transverse field, generate a demagnetizing field influencing the 90-deg domain. This field will deflect the M vectors (dipoles) from the 90-deg position.

The demagnetizing field due to neighboring domains, the transverse field, and the anisotropy properties determine the orientation of each dipole in this domain. The center of the area is less influenced by the neighboring demagnetizing field than the edges. Application of a second external field parallel to the preferred direction will either add to or subtract from the demagnetizing fields. This field will also cause the M vectors of domains in the central area to rotate from 90 deg toward the direction of the second field. The domains near the edges will rotate if the force of this field plus the demagnetizing field is sufficient to overcome the anisotropy field. Then the M vector will rotate past 90 deg toward the opposite state.

Removal of the transverse field leaves the dipoles close to the hard direction in an unstable state, and the resultant forces determine their return to 0 or 180 deg.

The M vectors lying opposite each other form a domain wall. This wall is stable as long as the dipoles on either side are in a minimum energy state. Consider only those domain walls that form the boundary between M vectors lying at 0 and 180 deg. A domain wall may be thought of as having a direction. This direction angle is referred to the preferred direction of magnetization. For films of the properties described, the stable domain wall angle is approximately 45 deg.

Some domains show a curved boundary, or wall. To identify the domain wall angle for a curved wall, it is the angle between the preferred direction and the tangent to the curve. Domain walls that might occur at angles greater than 45 deg will appear to grow until the angle is less than 45 deg. A field just greater than H_c in the preferred direction, from a current in a 10-mil-wide flat conductor, remagnetizes a narrow area of the film by a domain wall movement. The boundaries, to conform with the conductor, form 45-deg walls in a sawtooth pattern.

When the parallel field is removed, the newly formed domain breaks into small island domains. These islands are always longer in the preferred direction than in the hard direction. The breakup of this domain seems due to the demagnetizing field, a field which would like to maintain closed magnetic paths on the film. Where this field is larger than H_c, a reversal of magnetization takes place and forms these islands.

If a thin film is initially magnetized in the P state and a transverse field is applied to a narrow region, dipoles will rotate toward 90 deg. The demagnetizing field of the neighboring domains will generate a mmf, causing the dipoles to rotate past 90 deg. When the transverse field is removed, the mmf due to the demagnetizing field will rotate the dipoles to the N state. Thus, a domain of N state is formed in this narrow region, surrounded by a P domain. This new domain forms a closed magnetic path for the demagnetizing field and is, therefore, stable. If a transverse field is again applied, the dipoles will rotate toward 90 deg but will again return to the N state.

A domain exhibiting this behavior is called an irreversible domain. A similar situation occurs if the film is initially magnetized all in the N state—an irreversible P-state domain will be formed when a transverse field is applied and removed. The sequence in Fig. 1 shows the formation of such an irreversible domain. The first part (left) shows the dipoles aligned in the same direction. The second part shows a central region having its dipoles aligned 90 deg to the surrounding dipoles, as would be the case when a transverse field is applied. The third part shows the central region having its dipoles aligned opposite to the surrounding dipoles. This is the case after the transverse field is removed. The demagnetizing field will rotate the dipoles

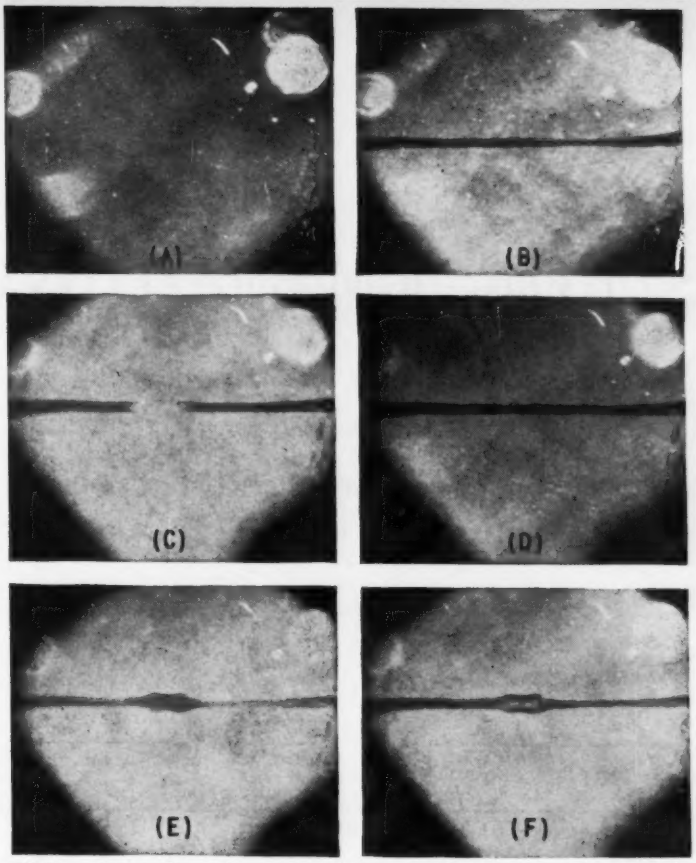


FIG. 3—Series shows formation of irreversible domain of P state (D), N state (F) when film is initially magnetized in the N state (A)

Pulse tests were carried out with films approximately 1 in. x 0.75 in. on a glass substrate of 1.5 in. x 1 in. x 0.05 in. See Fig. 4A. The easy direction of magnetization was parallel to the shorter edge of the glass. A sense conductor, No. 44 enamel round wire was laid perpendicular to the easy direction encircling the film and thence to a sense amplifier. Two 0.02 in. × 0.001 in. conductors on 0.04 in. centers were placed on either side of the sense conductor. This was the information conductor used to apply a parallel field to the film. This field was formed by applying 350 ma d-c. The read conductor was 0.01 in. × 0.001 in. encircling the film parallel to the easy direction. It was driven by two Hewlett-Packard 212A pulse generators connected to supply two 1 amp, 60 n sec pulses.

The first test used a single-turn read conductor. The film was placed in the *N* state by coincidence of a pulse on the read conductor and the correct polarity current on the information conductor. The information current was reduced to zero. The first pulse next applied caused two negative pulses to appear on the sense line, the first when the dipoles rotated from *N* to 90 deg, the second when they rotated from 90 deg to *P*. The sense-line pulses correspond to leading and trailing edges of the read pulse.

The second pulse caused the appearance of a positive followed by a negative pulse on the sense line. The positive is caused by rotation of the dipoles from *P* to 90 deg and the negative is caused by rotation from 90 deg to *P*. If the read pulse is the correct amplitude, about 750 ma, all subsequent read pulses will generate identical sense signals, approximately 7 mv. It was observed that the sense signal would decay if the current increased.

The film was placed in the *P* state by reversing the polarity of current on the information conductor and applying a read pulse. Subsequent read pulses caused all sense signals to reverse. The first read pulse caused the appearance of two positive pulses; all others generated a negative pulse followed by a positive pulse. (See Fig. 4B.)

A continuous readout of 1,000 pulses a second for one day indicated no change in the sense signal. Operation at 10 Mc was confirmed by placing two consecutive read pulses 100 nanoseconds apart and obtaining identical sense signals.

The second test used a 10-turn read conductor, each turn spaced 0.04 in. apart. The test procedure and results were the same except that the sense signal was 10 times greater. This indicates that only a localized area next to the conductor was rotated.

Appreciation is extended to E. Bittmann and P. Hoffman for their technical advice and help in obtaining experimental evidence.

BIBLIOGRAPHY

A. Arrott and J. E. Goldman, Fundamentals of Ferromagnetism, *Electrical Manufacturing*, p 109, March 1959.

K. Chu and J. R. Singer, Thin Film Magnetization Analysis, *Proc IRE*, p 1, 237, July 1959.

A. V. Pohm, Magnetic Film Memories, *IRE Transactions on Electronic Computers*, p 308, 1959.

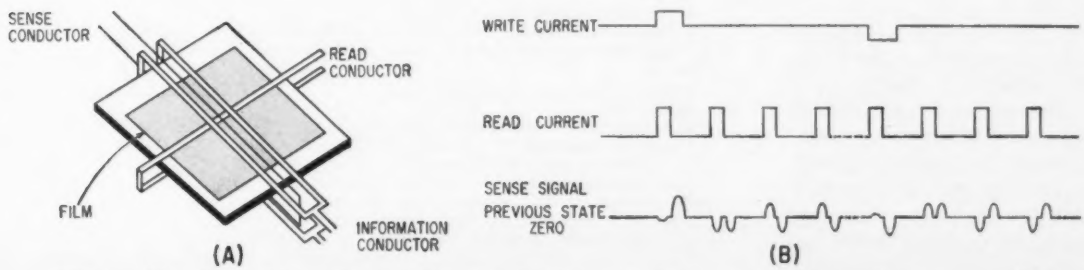


FIG. 4—Thin film wiring scheme (A) and coincidence of signals for nondestructive memory (B)

RESINS FOR EMBEDDING

Filler materials and their application, electrical and generalized bulk effects, and the effects of environmental extremes on embedding resins

By C. A. HARPER, Air Arm Division, Westinghouse Electric Corp., Baltimore, Maryland

THE MAJORITY of embedding resins used in electronics are improved for such use by a filler material added to the resin formulation. Although these fillers are often considered only as extenders that reduce the formulation cost, they have many more important electrical and physical effects. A knowledge of which filler can be used for which effect will allow the designer of electronic packages to better utilize the advantages of commercially available fillers. A tabulation of these application effects is given in Table I. Some electrical effects of fillers in polyester and epoxy resins are given in Table II.

Although there are a large number of fillers, each having different properties, generalities can be made regarding their application effects, regardless of the resin or filler used. Some of these generalized bulk effects important to electronic packaging applications are listed in Table III.

The information presented here is taken from a book entitled *Electronic Packaging With Resins*, by C. A. Harper, Westinghouse Electric Corporation, and to be published about April 1961 by the McGraw-Hill Publishing Co., Inc. Acknowledgement for portions of this information on fillers is made to

TABLE I—APPLICATION EFFECTS

Filler	Approx. Price Range cents/lb	Increases: Thermal Conductivity	Thermal Shock Resistance	Impact Resistance	Compressive Strength	Arc Resistance	Machinability	Electrical Conductivity	Decreases: Cost	Cracking	Exothermic Heat	Coeff. of Expansion	Density	Settling	Shrinkage
Bulk Fillers															
Sand	1	X[a]			X				Ⓧ		X	X			X
Silica	1–2	X			X				Ⓧ		X	X			X
Talc	1–4						X		X		X				X
Clay	1–3		X		X		X		X	X	X	X		X	X
Calcium Carbonate	0.5–5						X		X		X				X
Calcium Sulfate (Anhydr.)	2–4	X			X	Ⓧ			X		X	X			X
Reinforcing															
Mica	3–9		X	Ⓧ					X	X				X	
Asbestos	2–5		X	Ⓧ						X				X	
Wollastonite	2–3	X	X	Ⓧ					X	X					
Chopped Glass	15		X	Ⓧ						X					
Fiber Glass	——														
Wood Flour	——		X	X			X		X				Ⓧ		
Sawdust	——		X	X			X		X				Ⓧ		
Specialty															
Quartz	2–5	X		X	X					X		Ⓧ			X
Alumina	5–15	X	X		X						X	Ⓧ			X
Hydrated Alumina	3–6					Ⓧ								X	
Lithium Aluminum Silicate	——	X			X					X	X	Ⓧ			X
Beryl	——	X			X					X	X	Ⓧ			X
Silica Aerogel	30–80													Ⓧ	
Bentonite	5–15													Ⓧ	
Graphite	6–30						Ⓧ	X							
Powdered Metals	——	Ⓧ	X	X	X		X	X	X	X	X	X			X
Ceramic Spheres	75–150												Ⓧ		
Glass Spheres	——												Ⓧ		
Plastic Spheres	——												Ⓧ		

(a) Circles denote most significant uses

ELECTRONIC PACKAGING

TABLE II—ELECTRICAL EFFECTS OF FILLERS IN POLYESTER AND EPOXY RESINS

Property	Dielectric Strength, volts per mil	Power Factor at: 1 Mc	10 Mc	20 Mc	50 Mc	100 Mc	Dielectric Constant at: 1 Mc	10 Mc	20 Mc	50 Mc	100 Mc
Filler						POLYESTER RESIN					
None	250–300	0.018	0.031 (at 1 Kc)	0.045 (at 50 cps)	.....	0.016	3.13	3.18 (at 1 Kc)	3.91 (at 50 cps)	....	3.2
Alumina	270	0.0194	0.0188	0.0183	0.0176	0.0177	5.05	4.92	4.9	4.85	4.8
Mica	400	0.0213	0.0204	0.0197	0.0185	0.0176	3.62	3.53	3.5	3.47	3.44
Glass	380	0.0165	0.0171	0.0170	0.0165	0.0160	4.53	4.4	4.35	4.29	4.25
Calcium Carbonate	280	0.0173	0.0171	0.0170	0.0167	0.0164	4.75	4.63	4.60	4.55	4.51
						EPOXY RESIN					
None	320	0.029	0.029	0.028	0.026	0.020	3.9	3.75	3.7	3.65	3.6
Calcium Carbonate	370	0.026	0.026	0.026	0.025	0.023	4.45	4.2	4.2	4.15	4.05
Mica	420	0.035	0.034	0.032	0.030	0.026	4.05	3.9	3.85	3.75	3.7
Glass	370	0.026	0.026	0.026	0.025	0.023	4.05	3.9	3.85	3.8	3.75

TABLE III—GENERALIZED BULK EFFECTS OF FILLERS

Property of Resin	Effect of Filler on Resin
Dielectric Constant	The dielectric constant of the resin system increases as the filler concentration increases. This, however, varies widely, depending more on the specific filler than do the other generalizations herein
Arc Resistance	The arc resistance of the resin system is increased as the filler concentration is increased
Power Factor and Dielectric Strength and Physical Strength Properties	Effects of filler on power factor and dielectric strength are somewhat random, depending on the filler used and conditions of use. Also, generalizations are difficult for effect of fillers on physical strength properties of resins, since some fillers are reinforcing, while others are not
Thermal Expansion	The thermal expansion of the resin system is reduced as the filler concentration is increased
Shrinkage	The shrinkage of the resin is reduced as the filler content is increased
Viscosity	The resin viscosity is increased as the filler concentration increases. The filler particle shape, size and rheological properties control the degree of viscosity increase
Exothermic heat of reaction	The exothermic heat of the resin curing reaction will be reduced in proportion to the amount of filler added to the resin. The degree to which this reaction heat is reduced will depend on the thermal dissipation of the system. This generalization does not necessarily hold true for hollow, spherical fillers, which are, in effect, thermal insulators

Application of embedding resins for packaging electronic assemblies often requires that these resins be stable in one or more adverse environmental conditions. A judicious choice in resin selection can best be made by a knowledge of the effects of these extremes on the commonly used embedding resins. Table IV outlines these effects for a variety of environmental extremes and test parameters.

Acknowledgment for portions of the information in this section is made to H. K. Graves and M. A. Pizzino, Naval Material Laboratory, New York Naval Shipyard; L. S. Buchoff and C. H. Botjer, Electro Tec Corporation; E. L. Colichman and J. D. Strong, North American Aviation, Inc.; A. E. Javitz and H. E. Barkan, Conover-Mast Technical Publications Corporation.

(continued on p 132)

(continued from p 131)

TABLE IV—EFFECTS OF ENVIRONMENTAL EXTREMES ON RESINS

Environmental Extreme	Resin System	Parameter Studied	Observed Effects
Humidity	Polyester	Insulation resistance	Degrades from initial resistance of approximately 10^6 megohms to 1–10 megohms or less. Degradation rate varies with the specific system with some resins dropping to the minimum resistance in 10 days at 90–100 percent R.H., and others dropping gradually over a 10-day period. The resin contributes more than the filler to this degradation
	Polyester	Dissipation factor	Wide variation, with some resins increasing from 0.02–0.08 to 2–30 in a week and 40–150 in a month at 90–100 percent R.H. Best resins usually increase to 0.2–2.0 in a month
	Polyester	Capacitance	Wide variation with worst resins increasing from 30–40 pf to around 1,000 pf in a week at 95–100 percent R.H. Best resins increase to 50–60 in a week and 150–200 in a month.
	Epoxy	Insulation resistance	Slight degradation in 10–20 days at 90–100 percent R.H., from 10^6 to 10^4 megohms as worst condition. In many instances there is little or no change
	Epoxy	Dissipation factor	Only moderate increase from 0.005–0.01 to 0.005–0.1 in a week, and to 0.005–0.2 in a month at 90–100 percent R.H.
	Epoxy	Capacitance	Only moderate increase from 25–40 pf to 30–60 in one week and 30–80 in a month at 90–100 percent R.H.
	Epoxy	Surface resistivity	Slight decrease from over 10^{14} ohms at 75 percent R.H. to 10^{12}–10^{13} ohms at 80–90 percent R.H. Novolac epoxy cured with aromatic amine did not drop similarly until about 95 percent R.H.
	Epoxy (filled)	Surface resistivity	Decreases from 10^{13} ohms to 10^{10}–10^{11} ohms at 80 percent R.H. or above with calcium silicate filler. Decreases to only 10^{11}–10^{12} ohms at 85–90 percent R.H. for mica, silica and calcium carbonate fillers. These decreases are all worse than for an unfilled resin
	Silicone	Insulation resistance	Approximately equivalent to epoxy resins, as listed above
	Urethane foams	Insulation resistance	Similar to or worse than that listed above for polyesters. This will vary somewhat depending on resin type (e.g., polyester, polyether; one-shot, prepolymer) and on foam density and cell structure. Moisture permeability is reduced as the foam density increases, the cell diameter is reduced, and/or the percentage of closed cells is increased
	Epoxy foams	Insulation resistance	Generally the same effects as for urethane foams. This is approximately true for all type foams due to their cellular nature.
Low Temperature and Thermal Shock	Polyester	Crack resistance	Crack badly at temperatures of −55 to −65 C. Cracking can be improved somewhat by use of fillers, especially fillers that decrease thermal coefficient of expansion of the system, and reinforcing-type fillers
	Epoxy	Crack resistance	Rigid resins crack moderately to badly at temperatures of −55 to −65 C. Cracking is generally not as bad as with polyesters. As with polyesters, fillers offer considerable improvement in crack resistance. Also, epoxies can be made resilient by use of proper curing agent, reactive diluent or modifier. Many of the resilient formulations have excellent crack resistance
	Silicone	Crack resistance	Similar to polyesters for rigid, solventless silicones. Silicone rubber compounds, being resilient, have excellent crack resistance
	Polysulfide	Crack Resistance	Usually good crack resistance due to tough, resilient nature
	High density urethanes	Crack resistance	Usually good crack resistance due to tough, resilient nature
	Foams	Crack resistance	Usually good crack resistance, being better for the more resilient foams.
Gamma radiation	Epoxy	Heat distortion temperature	No major change up to about 10^7 roentgens; heat distortion point generally decreases above this dosage
	Polyester	Specific gravity and water absorption	No major change in specific gravity and water absorption up to about 10^9 rads; above this, specific gravity decreases and water absorption increases
	Polyester	Light transmission	Decreases above 10^6 rads dosage from 85–90 percent transmission to less than 25 percent transmission above 10^9 rads
	Silicone	Various	Maintains properties after doses of 1,000 megarads
	Silicone rubber	Hardness	Becomes brittle after 100–500 megarad dosage

Root-Mean-Square Sensing in Voltage Regulators

By ROBERT L. FRANK,
Air Armament Division, Sperry Gyroscope Co., Great Neck, N.Y.

Direct voltage proportional to rms value of chopped sine or square waves is obtained from self-biased linear rectifier circuit intermediate in action between average and peak rectifiers. Circuit regulates to within fraction of one percent for wide variation of input voltage, load or ambient temperature

VARIATION in the firing angle of magnetic amplifiers and gas-filled or semiconductor controlled rectifiers is commonly used to control the output of voltage regulators. The usual output waveform is a chopped sine wave or a chopped square wave, as shown in Fig. 1.

Sometimes, as when controlling the heater supply to critical vacuum-tube circuits, it is necessary to control the rms value of the output. Usually, the regulator circuit requires a d-c control voltage. Common rectifier circuits are unsatisfactory. An average or unbiased rectifier gives a d-c voltage which decreases much more than rms as the firing angle is increased[1]; a peak rectifier circuit has the opposite failing. Therefore, many relatively complex schemes have been used.

Rectifier circuits intermediate in action between average and peak have long been known, although apparently seldom used[2]. The near rms response of intermediate rectifiers to a variety of specific waveforms has been depicted in detail[3, 4, 5], but operation with voltage regulator waveforms has not been previously considered. These circuits, when properly proportioned, closely approximate the rms value of chopped sine or square waves.

Several forms of intermediate rectifier circuit are shown in Fig. 2. In the full-wave bridge and center-tap circuits, (Fig. 2A) capacitor C is charged to the output voltage, and R_LC is made sufficiently great that there is relatively little variation in voltage over one cycle of the input voltage. The voltage to which C charges is determined by the ratio of R_s to R_L. The voltage on C acts as a back-bias on the rectifiers and constrains rectifier conduction to that time when the input voltage exceeds the bias voltage, as shown by the shaded portions of the waveforms in Fig. 2D.

In the sine wave the conduction angle, β, of the rectifier circuit is less than the duration of the chopped waveform.

Operation of the half-wave circuit, Fig. 2C, is similar to the full-wave circuits, except that conduction takes place only during one polarity of the input wave. The series resistor is one-half as large as in the full-wave circuits, so the charge added to the capacitor during each full cycle is the same, and the output voltage is the same.

In the voltage-doubler circuit, Fig. 2B, a d-c voltage of $E/2$ builds up on the series input capacitor. This acts as the back-bias for the lower diode. The difference between this voltage and the output voltage acts as a back-bias for the upper diode. The diodes conduct on alternate half-cycles of the a-c wave. The circuit is thus a true full-wave rectifier, notwithstanding the name half-wave doubler sometimes applied to this rectifier.

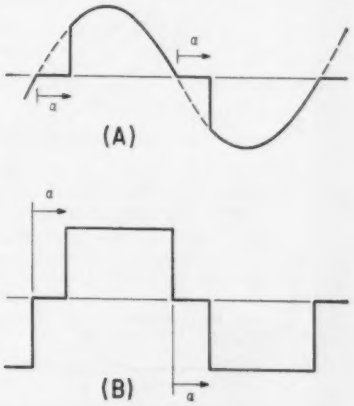


FIG. 1—Chopped sine wave (A) and square wave (B) with firing angle control

The performance of circuits with the resistance ratios specified in Fig. 2 is shown in Fig. 3A and 3B. Although the intermediate rectifier circuit closely approximates the rms value over the entire range of firing angle, the circuits and curves shown are optimized over the range usually met in voltage regulator circuits. Details of this range are shown in Fig. 3C and 3D. The intermediate rectifier output and true rms differ by less than one percent for regulation of at least ±15 percent.

When building intermediate rectifier circuits, capacitor C (Fig. 2) should be made sufficiently large that changes in its value do not affect the output voltage. This makes the circuit insensitive to changes in power-supply frequency. The doubler circuit requires R_LC values four times as great as the bridge or center-tap circuits for the same performance. The R_s/R_L ratio need not be exact to obtain rms characteristics, but R_s and R_L do form a voltage divider, and stable resistors are required for precision applications where a constant output voltage is desired. Source re-

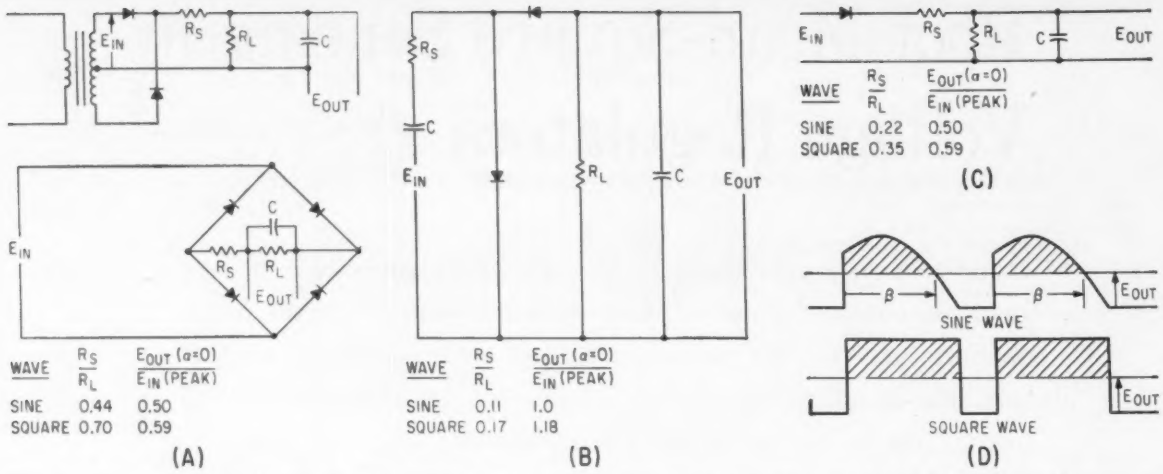


FIG. 2—Forms of intermediate rectifier circuit include center-tap and bridge circuits (A), doubler (B) and half-wave circuit (C). Intermediate rectifier conduction is illustrated in (D)

sistance and rectifier output loading must be considered when setting R_S and R_L. The bridge and center-tap circuits are less sensitive to loading than the doubler circuit. Those circuits will thus be preferable except for those applications where the common input-output terminal and higher output of the doubler circuit are dominating factors.

The half-wave circuit is simple and is recommended for lower-precision applications. Its disadvantage, compared to the full-wave circuits, is that it is sensitive to nonsymmetry (even-order distortion) in the input waveform.

The resistance ratio of the sine-wave circuit is the same as that used in the harmonic insensitive or "120-degree conduction" rectifier[4]. The resistance ratio shown for the square-wave circuit was calculated to give equal error at 0 and 90-degree firing angle. The solution for sine waves involves transcendental equations solved by successive approximations; the solution for square waves requires simple algebra only. All calculations were made to slide-rule accuracy.

A coworker, F. Zavatto, has built a-c sine-wave regulators using controlled semiconductor rectifiers that regulate the rms value to within 0.2 percent for the combined effects of input voltage variation of ±10 percent and a load variation of 1 to 10. The regulation is within one percent over an ambient temperature range of −55 C to +55 C.

In these regulators, the voltage to be regulated is fed to an intermediate rectifier using silicon diodes in a full-wave bridge circuit. The output of the rectifier is compared with a Zener reference diode, the difference voltage is amplified by a transistor and used to control the firing angle of a pair of back-to-back silicon controlled rectifiers in series with the a-c power line. The basic control circuits have been described elsewhere[6].

By slightly varying the resistance ratio in the rectifier circuit, it is possible to change the shape of the regulation curve and experimentally compensate for second-order effects in regulator circuit or load, and even to produce over-compensation to allow for voltage drop in the source.

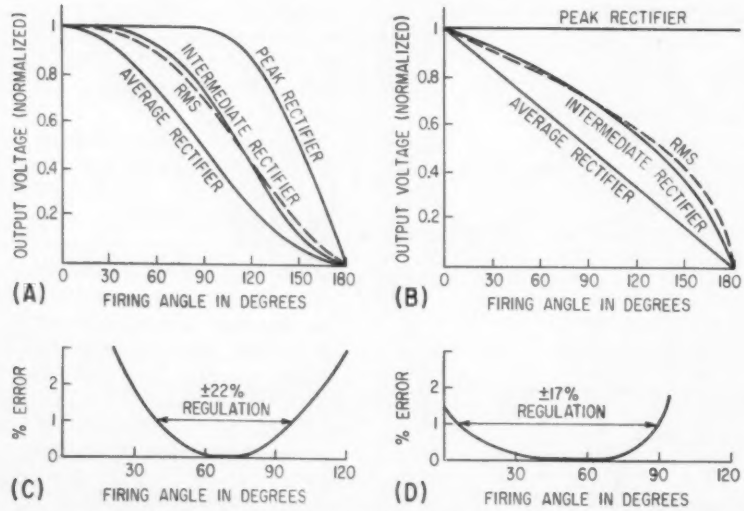


FIG. 3—Rectifier performance is shown for chopped sine waves (A) and chopped square waves (B); departure of output from rms (normalized) is shown in (C) for sine wave and in (D) for square wave

REFERENCES

(1) J. S. MacDougall, Curves Find Values of Chopped Waveforms, ELECTRONICS, p 46, Dec. 25, 1959.

(2) W. V. Richings and B. J. White, Transistorized Sound Level Meter, ELECTRONICS, p 64, June 17, 1960.

(3) H. Bouke, A Novel RMS-Value Rectifier with Reduced Waveform Error, *Archiv der Electrischen Ubertragung*, p 267, July, 1950.

(4) R. L. Frank, Harmonic-Insensitive Rectifiers for A-C Measurements, *Proc 1952 National Electronics Conference*, p 495.

(5) E. Durbin, A Root Mean Square Reading Rectifier Voltmeter, Master's Thesis, Polytechnic Institute of Brooklyn, May, 1954.

(6) F. W. Gutzwiller and others, General Electric Controlled Rectifier Manual, Section 7, General Electric Co., Liverpool, N. Y., 1960.

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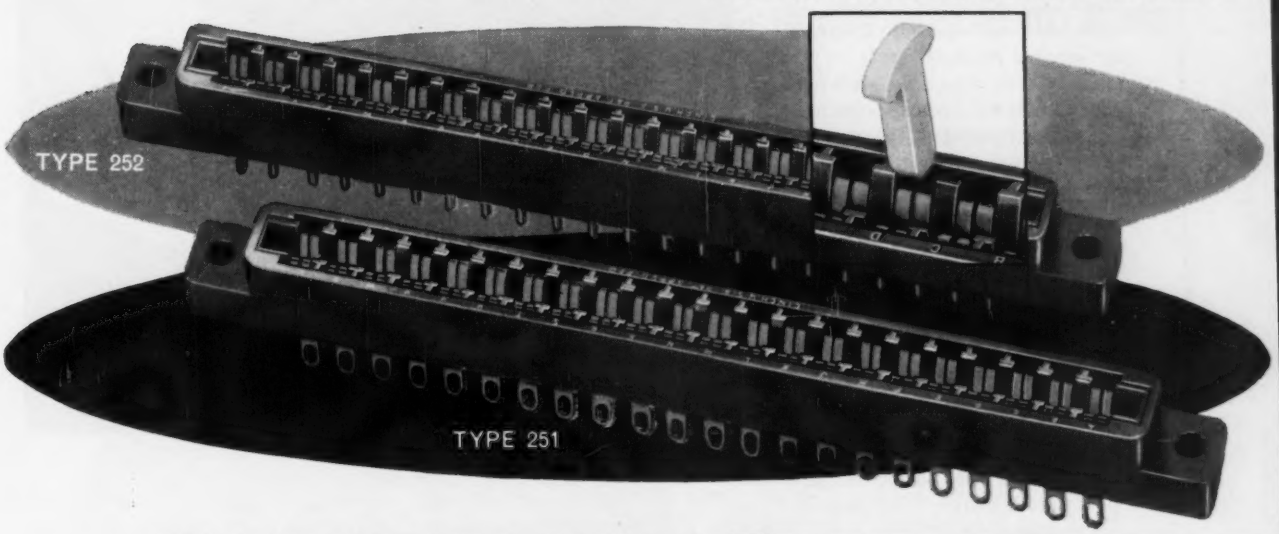

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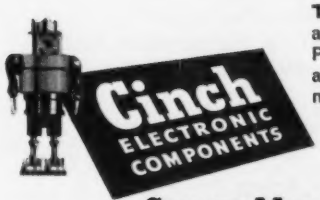

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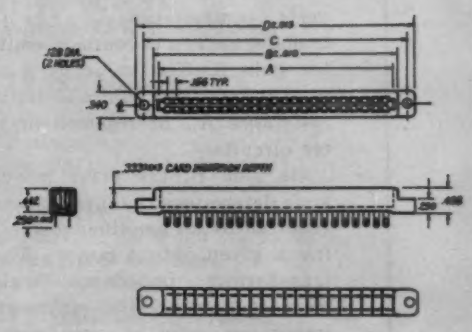

Contact* Positions	DIMENSIONS			
	A	B	C	D
6	1.098	1.239	1.531	1.785
7	1.254	1.395	1.687	1.941
8	1.411	1.552	1.844	2.098
9	1.567	1.708	2.000	2.254
10	1.723	1.864	2.156	2.410
11	1.879	2.020	2.312	2.566
12	2.036	2.177	2.469	2.723
13	2.192	2.333	2.625	2.879
14	2.348	2.489	2.781	3.035
15	2.504	2.645	2.937	3.191
16	2.661	2.802	3.094	3.348
17	2.817	2.958	3.250	3.504
18	2.973	3.114	3.406	3.660
19	3.129	3.270	3.562	3.816
20	3.286	3.427	3.719	3.973
21	3.442	3.583	3.875	4.129
22	3.598	3.739	4.031	4.285
23	3.754	3.895	4.187	4.441
24	3.911	4.052	4.344	4.598
25	4.067	4.208	4.500	4.754

*Number of contacts equals contact positions times two.

Transistor Amplifier Slide-Rule Calculator

By J. HALLIS, Goodyear Atomic Corp., Portsmouth, Ohio*

THIS SLIDE RULE provides a fast, accurate method for calculating transistor amplifier values. Its accuracy has been substantiated by several hundred tests of actual circuits. The rule[1] shown in Fig. 1, will aid the experimenter in using various inexpensive transformers in transistor circuits.[2]

Drawings of the individual components of the slide rule, Fig. 2, are suitable for assembly into a pocket-size rule.

Side A has three load impedance scales. Two of these are for class A and one for class B.

Load impedance scale: set the slide to value of supply volts, E_c, above the scale to be used. Below the desired power output read the required load impedance on the slide.

The α-β conversion scale converts common-base current transfer ratio α to common-emitter gain β. The value of β is used to calculate gain and input resistance R_{in} of common-emitter circuits.

On side B, the drive power scale determines the input power required by an amplifier delivering a given output power. The transformer impedance scale helps determine the unknown impedance ratio of any transformer. For example, a filament transformer with a 115-volt primary and a 6-volt secondary has a primary impedance of 1,000 ohms and secondary impedance of 50 ohms. When the secondary is used as a primary and the primary as the secondary, the input impedance becomes 1,000 ohms and the output impedance becomes 16,000 ohms.

* Presently at University of Kentucky Medical Center, Lexington, Kentucky

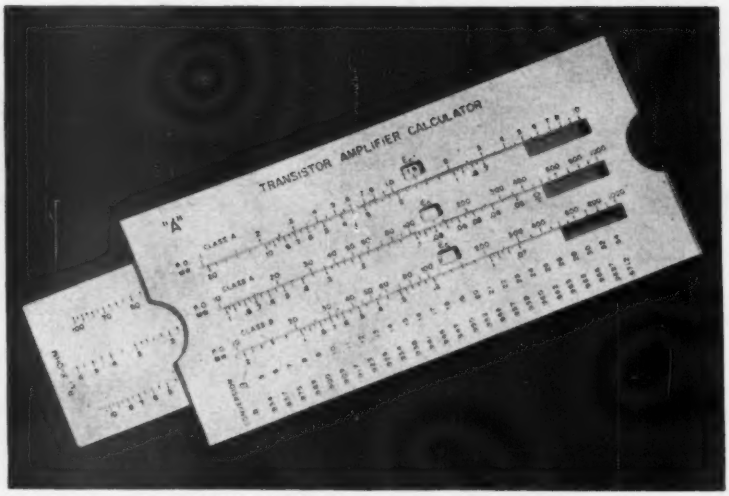

FIG. 1—The assembled calculator

The input resistance scale, R_{in}, was prepared for use with an emitter current I_e of 5 milliamperes.

To use the drive power scale, first obtain the db power gain of the transistor from manufacturer's specifications. A typical value of 22 db can be used if specifications are not available. Move the slide to set the db power gain over the power output of the stage, and read the required driving power above the arrow.

To use the transformer impedance scale, first apply an a-c voltage to the transformer under test. This may be done with a signal generator supplying 400 cycles or with a 60-cycle filament transformer using a potentiometer as an attenuation control. Move the slide so that the mark is above the value of the input voltage, and read the impedance ratios in the top window.

To determine R_{in}, the input resistance, read R_{in} at an emitter current I_e of 5 milliamperes opposite the β of the transistor. For any other value of I_e, multiply the R_{in} by 5 milliamperes divided by the new emitter current. For example, β of 10 at 5 ma I_e:R_{in} = 66 ohms. At 1 ma I_e, R_{in} = 66 ohms $\times$ 5ma/1ma = 330 ohms. β can be determined from the α-β scale or from the transistor manufacturer's specifications.

To obtain maximum fidelity from a transistor circuit, it is desirable to design for 25 percent more power than will be used.

The slide rule compensates for the power loss occurring in bias resistor networks and in the subminiature transformers usually associated with transistor circuits.

REFERENCES

(1) This work was performed under contract AT-(33-2)-1 with the U. S. Atomic Energy Commission.
(2) R. F. Shea, "Transistor Circuit Engineering," John Wiley and Sons, New York, 1957.

(Continued on p 138)

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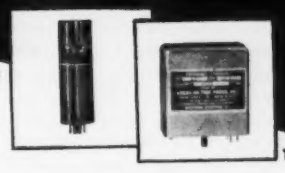
This frequency standard (360 or 400 cy.) is accurate to ± 25 parts per million at 10° to 35°C. The tuning fork is made from Iso-elastic alloy and is approximately 1 inch long. Fork aging has been greatly minimized. Compensation in the circuit provides a minimum rate change throughout the useful life of the power cell (over a year). External power of 1.4 volts at approximately 6 microamperes can also power the unit. An hermetically sealed model, Type 15, is also available.



TYPE 2007

TYPE 15

For more than 20 years, this company has made frequency standards and fork oscillators within the range of 30 to 30,000 cycles for applications where consistent accuracy and rugged dependability are demanded. A few examples are shown and described here.

Some users integrate these units into instruments of their own manufacture. Others rely on our experience and facilities to develop complete operating assemblies to meet their special needs.

You are invited to submit any problems within the area of our activities for study by our engineering staff.

TYPE K-5A FREQUENCY STANDARD

Size, 3½" x 3" x 1¾"
Weight, 1½ lbs.
Frequency: 400 cycles
Accuracy: .03%, −55° to + 71°C
Input: 28V DC ±10%
Output: 400 cy. approx. sq. wave
at 115V into 4000 ohm load (approx. 4W)

TYPE 2007-6 FREQUENCY STANDARD

Transistorized, Silicon type
Size, 1½" dia., x 3½" H., Wt., 7 oz.
Frequencies: 360 to 1000 cy.
Accuracies:
2007-6 ± .02% (−50° to +85°C)
R2007-6 ± .002% (+15° to +35°C)
W2007-6 ± .005% (−65° to +85°C)
Input: 10 to 30V DC at 6 ma.
Output: Multitap, 75 to 100,000 ohms

TYPE 25 PRECISION FORK

Size, ⅜" dia. x 2⅛"
Weight: 2 ounces
Frequencies: 200 to 1000 cy. (specify)
Accuracies:
R-25T and R-25V ± .002% (15° to 35°C)
25T and 25V ± .02% (65° to 85°C)
For use with tubes or transistors.

TYPE 15 FREQUENCY STANDARD

Similar to Type 10 (illustrated) except with silicon transistor, hermetically sealed and vibration resistant.
Size, 1" x 2" x 2" high
Tolerance, ± .01% from −40°C to + 71°C
Output: .IV at 50,000 ohms source impedance.

ATP

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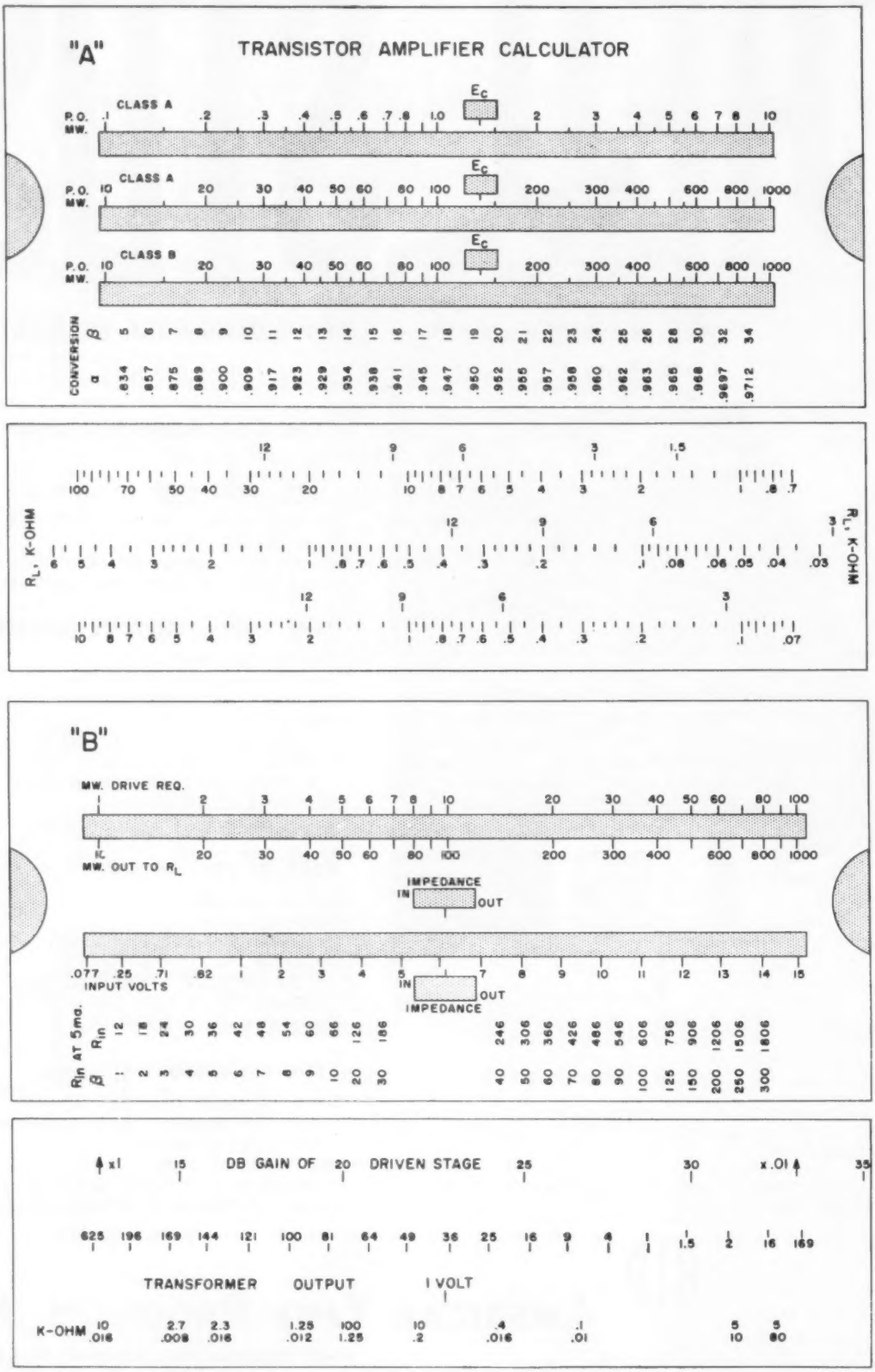
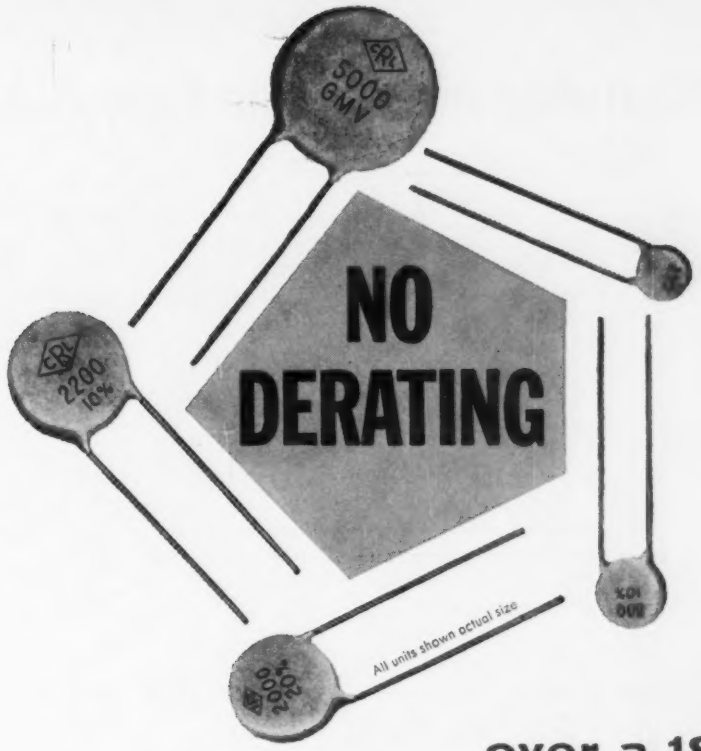


FIG. 2—Components of calculator can be cut out, pasted on cardboard and assembled into rule

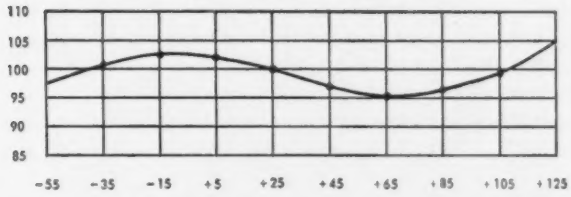


over a 180° C range with Centralab's temperature stable Ceramic Capacitors

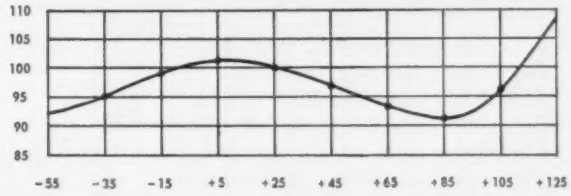
These low-cost Type CE ceramic disc Hi-Kaps® have been extensively tested over an 18 month period by prime contractors in the missile and radar fields. Their findings: *the excellence of the* CENTRALAB *design parameters for standard commercial units permits the identical capacitors to be used in military applications.*

In radio-TV as well as military usage, these units operate from —55° C to +125° C without derating. They last longer than paper or mica capacitors, and their small size makes them economical to work with. Semi-stable Type CF CENTRALAB Hi-Kaps® offer similar advantages.

TYPE CE—% of 25°C Capacity vs. Temperature in °C



TYPE CF—% of 25°C Capacity vs. Temperature in °C



SPECIFICATIONS

CAPACITIES: 150-6200 mmf
SIZE: .290"—.920" diameter, .156" thick
WORKING VOLTAGE: 500 VDC
LEAKAGE RESISTANCE: Initial, 10,000 Megohms minimum; after humidity test, over 1000 Megohms
POWER FACTOR: 2% Max. at IKC
TOLERANCES: GMV, ±20%, ±10%, +80—20%

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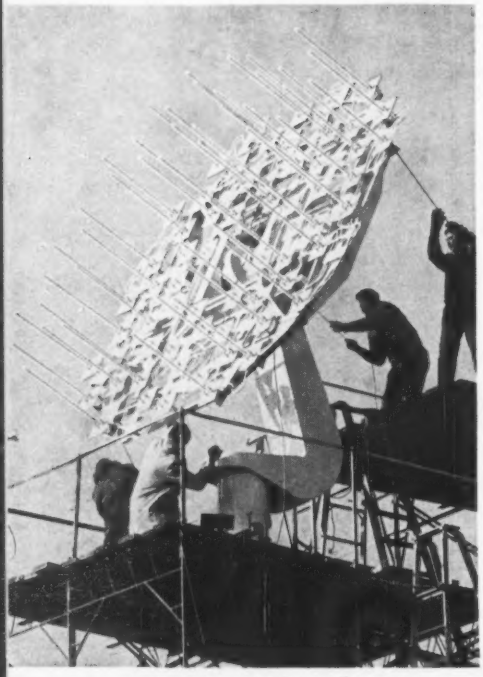
High-Gain Modular Array Has Low Side Lobes



THE FRONT COVER. *Because array being assembled rotates about center of gravity, no counterweights are needed*

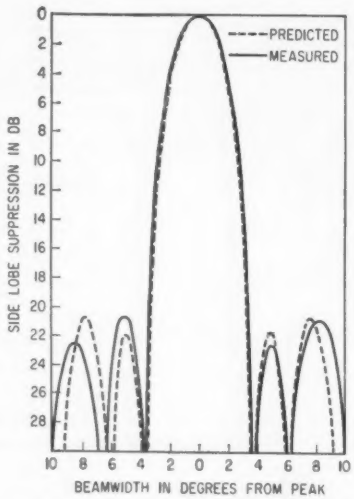
UNUSUAL combination of electrical and mechanical characteristics has been achieved in an acquisition and tracking antenna array constructed from uniform modular elements. The flexible, easily assembled array is comprised of individual disk-rod, end-fire elements. It operates over both the 1,435-1,535 Mc and the 2,150-2,350 Mc uhf telemetry bands.

The antenna shown in the photograph was designed by Avien in accordance with specified requirements of Cubic Corp. for Edwards Air Force Base. It demonstrates the large bandwidths, predictable gains and patterns, and the desirable mechanical properties obtainable with this type antenna. Significantly higher gains will be possible with larger arrays of this type now being designed.

Gain of each of the 68 elements in this array is about 13½ to 17½ db over a band of frequencies from 1,400 to 2,400 Mc. Array gain in producing the narrow-beam pattern illustrated is from 30 to 34 db. Fewer elements could provide equivalent gain if bandwidth requirements were not so severe. Gain of 36 db has been obtained using the same array with slightly longer elements over the upper telemetry band (2,150 to 2,350 Mc).

The antenna has three automatic tracking modes that could be automatically programmed to receive telemetry information at completely unmanned ground installations. A single element is used for a wide-beam (50-60 degrees at half-power points), unambiguous acquisition mode. All 68 elements provide an extremely narrow beam (2-3 degrees) mode that provides high signal-to-noise reception. Finally, a medium beam (12-16 degrees) mode permits automatic tracking and continuous telemetry reception through zenith. This mode, using four modular elements, also allows re-acquisition after temporary loss of the telemetry beacon signal.

In designing the array, Avien sought to derive maximum benefit from the performance characteristics of individual Bogner elements. The type element used comprises a uniform disk-on-rod structure launched (excited) by crossed dipole pairs above a small ground plane. These bipolarized elements are characterized by large bandwidths and high gain for their length. Power gain is about ten times element length in wavelengths and gain is constant within 3 or 4 db over almost an octave.



Close coincidence of predicted pattern with that actually measured for array is shown for narrow-beam operating mode at midfrequency of lower uhf telemetry band

In a relatively closely spaced array, mutual coupling and interaction among elements is low. Minimum interelement spacing is approximately the square root of element length in wavelengths. By using this spacing in the array, capture areas are kept contiguous yet isolation among elements is at least 40 db. Also, change in the pattern and gain of individual elements in the array is negligible.

Irregular distribution of the elements keeps side lobes low, as shown in the figure, despite the closeness of their spacing. The 68 elements ($2^6 + 2^2$) are fed in parallel and with equal amplitude.

The operating mode with the greatest gain and the narrowest beam is obtained using all elements of the array. The beam can be widened in steps for acquisition by switching to fewer elements in the central region of the array. For all beamwidths, the antenna is divided into identical quadrants that are interconnected by broadband hybrids to allow phase-comparison self-tracking. Amplitude-comparison, sequential-lobe and conical-scan tracking can also be achieved by altering interconnection of quadrants, switching or shifting of phase, respectively.

Small diameter foamflex was used in the feed system in this case because losses up to 1 db were tolerable. Lower losses will be encountered in larger antennas now being designed by Avien that use pressurized line. Path length to each ele-

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ACCURACY: 0.0001%, exceeding FCC requirements 5 times

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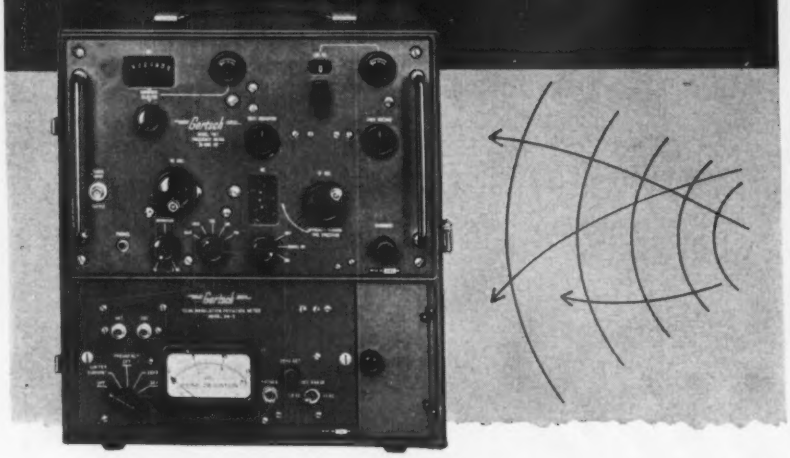

This portable instrument in one complete package enables you to measure both frequency and frequency deviations in the maintenance of mobile communications systems.

As optional equipment the FM-7 Frequency Meter can be combined with the new DM-3 Deviation Meter as illustrated. The DM-3 is a dual-range deviation meter with 15 kc. and 7.5 kc full scales.

By combining the FM-7 and the DM-3 you get a single instrument capable of measuring and generating carrier frequencies *plus* reading peak modulation deviation.

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ment in the array was kept identical within 4 electrical degrees.

Large steerable and fixed vhf and uhf paraboloids are heavy, expensive and difficult to erect. The modular array can be assembled from small identical sections that can be produced in quantity, which limits production costs. This type construction also permits fast changes in operating frequency band. The modular elements can simply be unplugged and replaced with elements having the desired characteristics. The pedestal, truss and most of the feed system can be used at the new frequency band. The four elements at the center of this array are also available as a unit for mobile or transportable use as a uhf antenna.

This uhf array presents a maximum effective area to the wind of 39 sq ft and is designed to withstand winds of 125 mph. It can be rotated about the center of gravity, eliminating the need for counterweights. Thus high accelerations are possible and pedestal operation is possible with about one-tenth the horsepower usually required.

The modular principle is also being investigated by Avien for development of portable, high-gain antennas. Collapsible, telescoping and inflatible versions are now being designed. Also, a novel launcher is in the final stages of development. It will provide simultaneous coverage of bandwidths greater than 5:1. Essentially constant capture area, high efficiency and high gain are maintained throughout this frequency range.

Space Study Will Use Ultraviolet Telescope

ULTRAVIOLET telescope is expected to provide more information about stars and interstellar space. Because ultraviolet is absorbed by the atmosphere, rockets and eventually artificial satellites will carry the equipment to altitudes of very low air density.

Heart of the system is an ultraviolet-sensitive tube called the Uvicon developed at Westinghouse Research Laboratories. The system will be used in Project Celescope

by the Astrophysical Observatory of the Smithsonian Institution. This project is one of several experiments related to the NASA orbiting astronomical observatory program. The first of the orbiting observatories is planned for 1963.

To sample the strength and nature of the ultraviolet radiation that will be encountered and to evaluate performance of the equipment, the ultraviolet system will be lifted above the atmosphere by rocket. The Aerobee-Hi rocket will be used in a series of launchings from the NASA Wallops Station.

The system comprises an optical assembly to form the ultraviolet images, a tv camera that uses the ultraviolet-sensitive tube to produce video signals and a transmitter to relay the information back to the ground.

The ultraviolet telescope package will be carried in the rocket nose cone to an altitude of about 150 miles. However, useful information will be obtained for only the 5-minute period that the rocket is above 60 miles. It is beyond this altitude that the ultraviolet radiation of interest ceases to be absorbed by the atmosphere. As the rocket reaches this altitude, the protective front covering of the nose cone will be jettisoned to expose the equipment.

The 2-inch diameter Uvicon is about 12 inches long and weighs about 8 ounces. Its operating range is from 1,200 to 2,000 Angstroms. It receives the ultraviolet image through a lithium fluoride window. The back surface of the window is coated with a photoemitting material that releases electrons when the ultraviolet image strikes it. The electrons are accelerated by 15,000 volts to a target at the rear end of the tube.

The electrons produce a charge on the target the pattern of which is the same as the ultraviolet image. The rear surface of the target is scanned by an electron beam to produce the video signal for transmission back to the ground.

Brightness of the stars telemetered in this manner will be recorded for final analysis of stellar magnitudes. Sources of ultraviolet in interstellar space will also be recorded.

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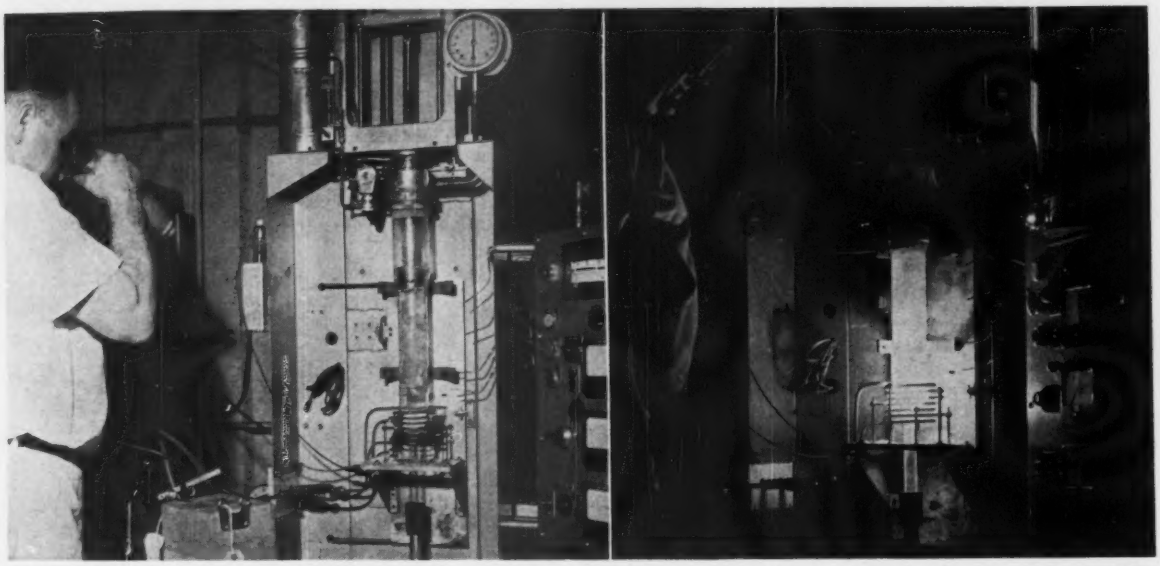

Vertical crystal puller, in which Merck produces single-crystal gallium arsenide, is shown in the photos above. Horizontal furnaces are also employed. Recent developments in the technology of GaAs crystal growth augurs well for the manufacture of tunnel diodes and uhf devices, and may open doors for a new line of semiconductors

What Lies Ahead for Gallium Arsenide?

By MICHAEL F. TOMAINO,
Associate Editor

THE STATUS of gallium arsenide for use in semiconductive components may be compared to the status of silicon about four years ago. However the potential of gallium arsenide will depend upon how many GaAs devices will be made and sold in the next five years.

A handful of top semiconductor manufacturers have been taking a close look at gallium arsenide, and within the past few weeks this column has been watching to see what can be done with this material. Some materials men are banking on a good future.

It has been known for some time that the greater band gap and potentially greater mobility of GaAs make this material dominant over silicon and germanium for both high-frequency and high-temperature performance. However, the key to this potential lies in the technology of crystal growth, techniques of chemical and metallurgical purification, incorporation of foreign atoms for desired electrical properties, and evaluating device configurations measured at various power levels.

In gallium arsenide, the technology problem of growing single crystals have been solved by four techniques: the magnetic Czochralski; the horizontal Bridgman; the floating zone; and the gradient freeze technique. These methods have been described in the literature.[1] The most perfect crystals structurally speaking are made by the Czochralski growth technique whereby a seed is withdrawn from the melt and is rotated to maintain thermal symmetry and cylindrical geometry.

The horizontal Brigman technique seems to be the most useful in the routine preparation of single crystals of GaAs for physical measurements and device feasibility studies.

One problem still remains to seek the purity required that would obtain *transistor* devices: to obtain the highest purity in terms of uncompensated carriers of 1×10^{15} cm^3. This is another order of purity to that presently obtainable for the manufacturing of tunnel diodes.[2]

How far away does the solution to this last problem lie? The experts can't predict. But that's what they are working on now. *And the solution to this problem would open the doors to a whole new line of transistors.* Meanwhile the door is now open for the manufacture of tunnel diode and other related uhf devices.

Part of the answers are coming from organizations that are not only developing experimental GaAs devices, but also growing their own materials. And the greatest advances are being made by those people who are experimenting with crystal growing techniques in their own laboratories. For device development engineers require close collaboration with materials men who know special growing techniques that enable them both to obtain high-purity materials with high mobilities. Some well established firms like Texas Instruments

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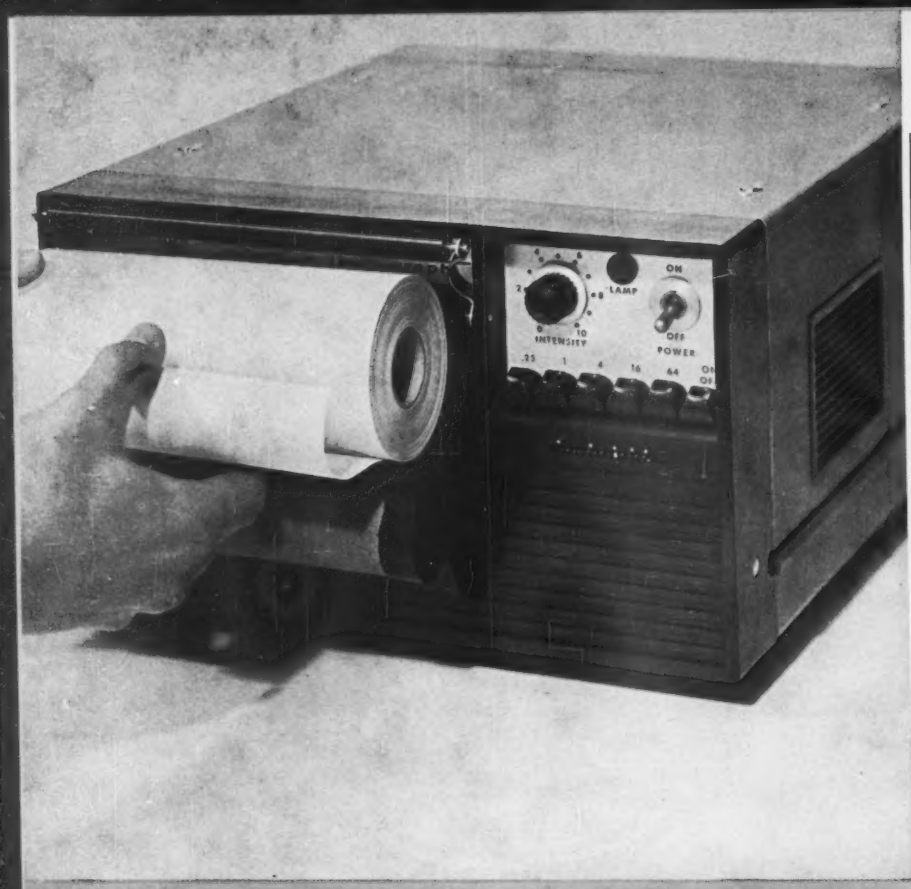

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and RCA are taking this tack. As well as new arrivals like Micro State Electronics Corp., of Murray Hill, N. J.

Micro State was formed last July and didn't really get going until last September. This company was started by five men well known to the semiconductor field.

The emphasis of this young company is on applied research, development and production in the field of solid-state electronics, especially in the uhf and microwave regions. The corporation has adopted the basic philosophy of integration of developmental efforts in solid-state materials and semiconductor devices with similar activity in microwave components.

As a result, Micro State now offers n-type single crystal gallium arsenide with mobilities ranging from a minimum of 3,500 cm^2/volt sec to over 5,500 cm^2/volt sec. The quality of this material is demonstrated by a large increase in mobility at low temperature and by uncompensated carrier concentrations in the order of 10^{16} per cm^3. In addition to the high-purity material which is desirable for basic material investigations and transistor and rectifier work, doped single crystals with impurity densities suitable for varactor and tunnel diodes are available. At Micro State, both single and large grain polycrystalline material come in semicircular ingot form, ¾-inch in diam, weighing approx 20 grams per linear inch.

Micro State grows their crystals by special techniques they would rather not discuss at this time. Mobility and resistivity data is supplied by the manufacturer with all single crystal material. Measurements are made on an ultrasonically formed Hall sample from material immediately adjacent to that supplied by the purchaser.

The Hall sample used by Micro State to evaluate the material can be purchased on request. Doped and 3,500 cm^2/volt sec minimum mobility materials are available in different prices for quantities of either 10-44 grams; 50-99 grams; and 100 grams or over. Crystals with minimum mobility of 4,500 cm^2/volt are offered in the same quantities.

The large grain polycrystalline material can be purchased in quan-

← CIRCLE 146 ON READER SERVICE CARD

tities of 20-99 grams; or in quantities of 100 grams or over. Minimum order is 10 grams for single crystal material, and 20 grams for polycrystalline material.

In addition to supplying gallium arsenide, Micro State has plans for making their own devices: varactor and tunnel diodes, and devices directed toward uhf and microwave.

Merck & Co of Rahway, N. J. who has been active in the semiconductive materials area recently announced their single crystal gallium arsenide in both doped and undoped form with carrier concentration ranging from 1×10^{16} carriers per cu cm to degenerate levels, and can deliver crystals to a doping tolerance of ±50 percent. Dopants employed are zinc, tellurium and tin. At Merck, single crystal gallium arsenide has been produced in ingots as large as 90 grams and in diameters up to one inch[4].

In addition to the single crystal form announced, Merck offers polycrystalline gallium arsenide. Carrier concentrations for both types are: less than 5×10^{16} (undoped); 5×10^{16}—5×10^{17} (undoped); 5×10^{17}—1×10^{19} (doped); and greater than 10^{19} (doped). Prices per gram are available for both poly and single crystals. Minimum mobility of the undoped form is 2,500 cm^2/volt sec.

One contract for evaluating various semiconductor materials, including GaAs is now active. The basic approach involves the Hall effect mode and use of magnetic input for a-c and d-c field measurement, and both electric and magnetic inputs for the microwave power meter[5].

REFERENCES

(1) High-Temperature Semiconductor Devices, United States Department of Commerce, Office of Technical Services, Scientific Report PB 161541, Prepared by Radio Corporation of America, RCA Laboratories, Princeton, N. J. under Contract No. AF33(616)-5029, Distributed by OTS in the Interest of Science and Industry, Report date: 31 Oct., 1959.

(2) Private communication with F. D. Rossi, RCA Labs., Princeton, N. J.

(3) Sam Weisbaum, Aaron Kestenbaum, John Sie, Saul Lederhandler and Lorne Armstrong; Micro State Electronics Corp., 152 Floral Avenue, Murray Hill, N. J.

(4) Private communication with T. S. Benedict, Merck & Co., Intermetallics Production Department, Rahway, N. J.

(5) Hall Effect for Power Measurement, Ohio Semiconductors, Inc., AF30 (602)-2237 (RADC).

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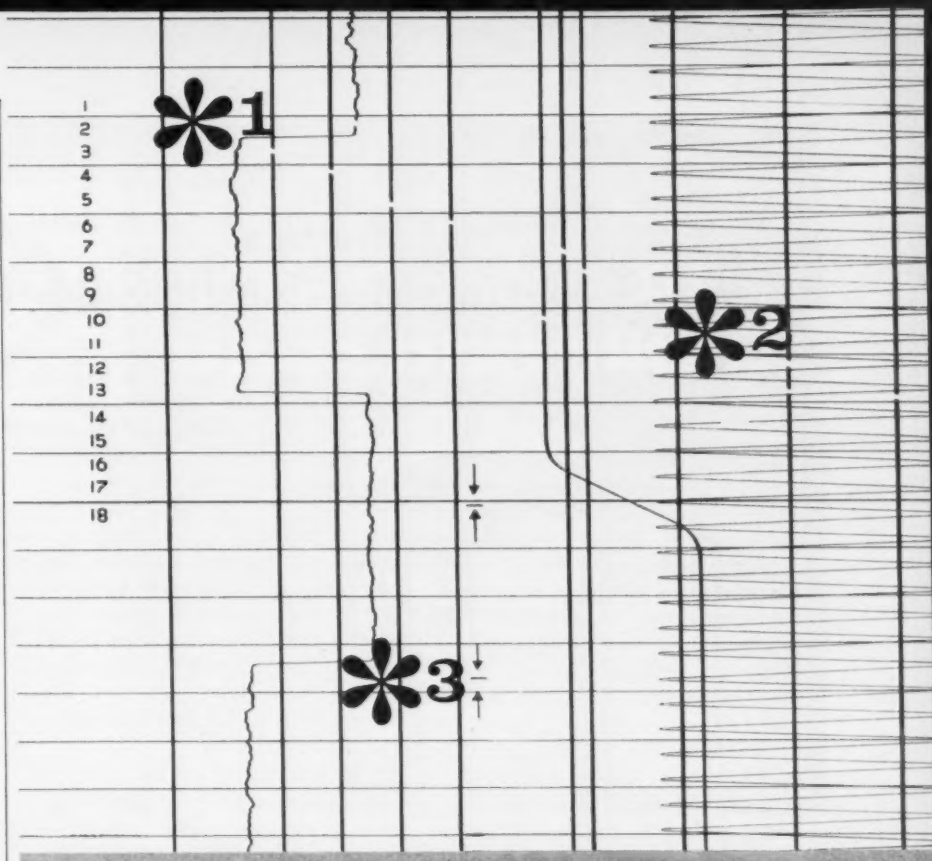

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Selecting the Right Soldering Iron

By J. D. KELLER, Group Leader, Metallurgical Engineering Department, The Martin Co., Orlando, Fla.

SOLDERING IRON EFFICIENCIES were evaluated here recently as part of a program to improve soldering techniques. The investigation demonstrated the benefits of selecting irons according to carefully-controlled performance tests instead of operator preference. Any manufacturer who doubts the quality of his irons might try the same simple tests.

As a result of the tests and the present use of only certified soldering irons at Martin-Orlando, rosin joints and cold joints have been eliminated. Adequate irons help reduce component damage, increase soldering rates, reduce operators fatigue and keep maintenance costs low.

Different types of irons made by different manufacturers were tested. Irons selected were 25-watt, for printed circuit boards; 50-watt, general purpose, and 150-watt, heavy duty. Heavy duty means soldering more than 700 joints an hour or soldering lugs larger than heavy turret lugs (0.02 pound).

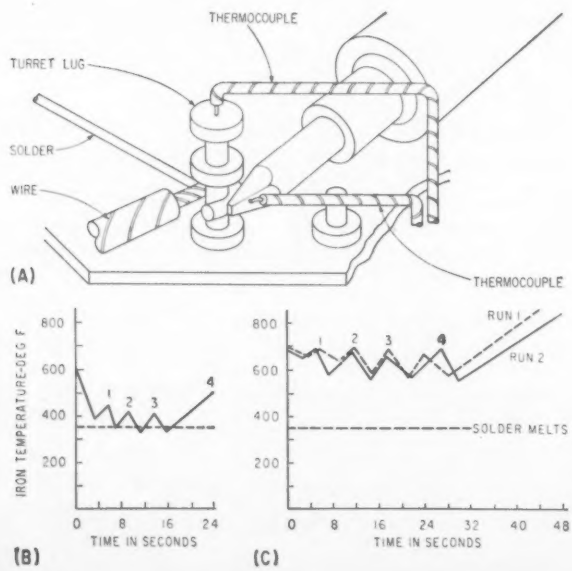
Tests were set up as in Fig. A. Chromel - Alumel thermocouples were attached to a lug and the iron tip. Lug and tip temperatures were plotted against time on a Sanborn twin-channel recorder, giving graphs like Figs. B and C. The recorder was calibrated before testing, using water at room temperature (70 F) and boiling water as the high and low temperature standards. Quality of each soldered connection was determined by mechanical and metallurgical tests and visual examination.

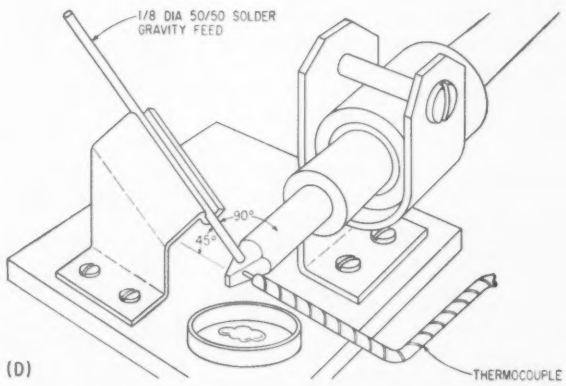
The best appearing and most reliable connections were soldered in $1\frac{3}{4}$ to $2\frac{1}{2}$ seconds at 500 F to 550 F. Too low a soldering temperature caused a rosin interface between terminal and wire, with a high-resistance connection caused by incomplete alloying. Cold joints resulted when the lug's base metal was not adequately heated. Many irons fell far short of giving sufficient heat for proper intermetallic formation between component lead and terminal. Large irons were not as effective as small irons in transferring heat from iron tip to terminal.

The performance of an unsatisfactory iron is given in Fig. B. After soldering only two turret lugs, iron tip temperature fell below the temperature required for reliable connections. Time increase between joints is also significant. The second joint was made $2\frac{1}{2}$ seconds after completion of the first joint. But the fourth joint required four seconds to complete after the iron was moved from the third joint.

Excessive solder to tip bridging was needed to solder in the times mentioned. Bridging pulled heat from the solder tip, lowering the temperature in the thermocouple area to below the solder's melting point. This iron does not have enough efficiency for high-quality soldering and does not hold sufficient heat from one connection to the next.

A review of the iron's performance on the production line confirmed the test. Operators were spending too much time bringing connections to soldering temperature and were attempting to overcome this by such practices as excessive bridging and carrying





Soldering iron efficiency tests are simple. Iron and lug tip temperatures (A) measured against time (B and C) and the rate at which the tip melts solder (D) indicate how well iron performs. Performance shown in B is unsatisfactory

NEW

MODEL 801H

a GOOD MEASURE of user benefits...

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INFINITE INPUT RESISTANCE AT NULL

UNKNOWN VOLTAGE

REFERENCE VOLTAGE

NEW! 1MV FULL SCALE NULL SENSITIVITY—RECORDER OUTPUT—AUTOMATIC LIGHTED DECIMAL-IN-LINE READOUT—TAUT BAND SUSPENSION METER

precision DIFFERENTIAL DC VOLTMETER

Using the same accurate principal to find the unknown as the beam balance, the Model 801H Differential Voltmeter gives you balanced accuracy, guarantees a "good measure for your money."

Like all ƒf differential voltmeters, the Model 801H provides infinite input impedance at null over the entire 0-500 Volt range. This ƒf feature is unique on today's voltmeter market and is of prime consideration when making precise DC measurements. The source loading of 1 to 10 megohms above a nominal 10 volts, which is inherent in other differential voltmeters now available, cannot be tolerated when 0.05% or better accuracy is to be maintained.

PARTIAL 801H SPECIFICATIONS

Voltage Ranges:	0.5, 5, 50 and 500V DC
Accuracy:	0.05% from 0.1 to 500V 0.1% or 50uv, whichever is greater, below 0.1V
Null Sensitivity Ranges:	10V, 1V, 0.1V, 0.01V and 0.001V
Maximum Meter Resolution:	5uv
Input Impedance:	Infinite at null
Dimensions:	Cabinet 9¾" W x 13½" H x 14" D Rack 19" W x 8¾" H x 13¼" D
Weight:	Cabinet 25 lbs., Rack 28 lbs.
Price:	Cabinet $555.00, Rack $575.00 Prices F.O.B. factory, Seattle

Extreme accuracy and stability are achieved by advanced circuit design which incorporates a chopper stabilized null amplifier and a standard cell reference.

Prices and technical data subject to change without notice.

Write for complete specifications.
Also ask for information on the ƒf A-70 recorder, companion to the 801H, and the Model 803.

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AIRPAX
and
TELEMETRY

The Airpax all solid state Multichannel Frequency Discriminator uses a single front panel switch to select each of the 23 IRIG telemetry channels. The input comb filter extracts the required single channel frequency from the composite telemetry signal.

The meter displays an analog presentation of percent deviation from channel center frequency. Terminals are provided for a 1 megohm recorder load. Meter accuracy permits using the unit as a standard for calibrating voltage controlled oscillators and similar devices.

Input is 10 millivolts minimum, with a 60 DB dynamic range. Linearity is 0.25% or better of bandwidth and drift will not exceed 0.3% of bandwidth after initial warm-up.

Airpax also produces this unit without the comb filter as well as individual units for single channel monitoring. Single channel types have plug-in components permitting adaptation to any desired channel.

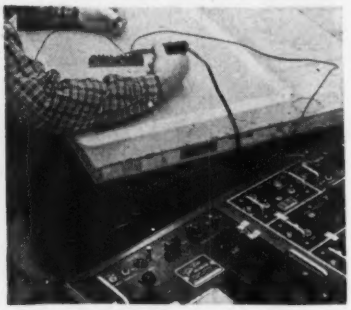
All units are priced considerably below comparable equipments. Size, weight, and power input are minimal.

SB42

solder on the tip to the lugs.

A satisfactory iron gave the performance indicated in Fig. C. Even after maximum temperature drop, iron temperature was still above the melting point of solder.

Results were further confirmed by tests (Fig. D) which measured the efficiency of the irons, with power on, and their heat reserve, with power off. First, with power on, a record is made of grams of solder melted per second and drop in tip temperature. After a set period, the iron is disconnected and a record made of solder melted per second until the rod of solder freezes on the iron tip.



Performance test being made

In the following table, efficiency and heat reserve are rated in grams of solder melted per input watt-second. The unsatisfactory iron has only 26 percent of the satisfactory iron's efficiency and only 32 percent of its heat reserve.

Iron	Eff. (10^1)	H.R. (10^2)
Satisfactory (55-w input)	65.0	28.4
Unsatisfactory (57.6-w input)	16.8	8.9

The tests also revealed that high temperature for an overly-long period, not high temperature alone, caused component damage. For example, no damage occurred when soldering was done at 525 F for $1\frac{3}{4}$ seconds. But soldering at 400 F for longer periods loosened lugs in plastic-glass terminal boards and destroyed sensitive components.

All soldering irons must be equipped with three conductors to protect delicate components and operators from shorts and voltage leaks. Also noted was the reduction in operator fatigue when a lightweight iron with a cool handle was used. New irons meeting these

criteria have been received favorably by operators.

Slide-Out Storage Racks File Parts

Racks hold over a million resistor bobbins and wires

STOCKROOM organized like a filing cabinet is used by General Resistance, Inc., New York, N. Y., to store wire-wound resistor materials. Production runs are kitted in the room.

Sliding storage racks occupy one end of room. The racks pull out into an open area reserved for passage of tote tray trucks. General contents of each rack is noted on the ends of the racks and the contents of each carton is written on the carton end exposed when the rack is pulled out.

The racks are fitted on top with sliding door hardware. Bottom guides are plywood rectangles mounted upright on the floor. The guides fit between two strips of wood fastened lengthwise on the bottom of each rack.

Portable Packager

Lightweight machine for skin-packaging parts has been introduced by MfP Co., San Mateo, Calif. Parts placed on corrugated board are covered with plastic film. Machine is made of aluminum and mounted on wheels

STRAIGHT, AND GOING SOMEWHERE

pretty well describes the clear-cut structure of electronic systems management within Alpha Corporation. The engineer who supervises team development of a program proposal is in direct contact with the client. After the contract is signed, management, engineering and administrative talents are coordinated within the project division, and the engineer, as Project Director, has complete authority and responsibility for the project's execution.

Alpha offers opportunities on creative teams for people with specialized capabilities in determining system parameters; integrating a complex of equipments; directing subsystems suppliers. Write: C. P. Nelson, Employment Manager

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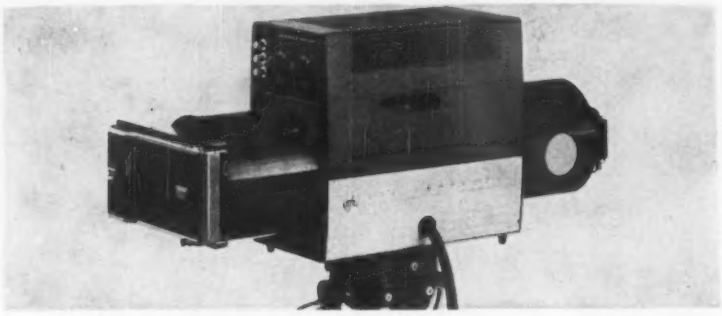
New On The Market



High-Speed Camera

20 × 10^9 FRAMES PER SEC

IMAGE converter camera, to be marketed early in April, is diagnostic tool for high-speed luminous events in plasma physics, chemical kinetics and hypervelocity experiments. The camera will take photographs at exposure times of three nsec to 200 nsec. Three-picture series can be made at rates of half to twenty million exposures per second. Streak photographs may be taken at writing speeds of four to 1,000 mm per nsec.

The camera converts an optical image to an electron image, which allows electronic shuttering, light amplification and image deflection. Conversion of the light image is accomplished with an image converter tube. Focused light strikes the photocathode of the tube, thus effecting the conversion.

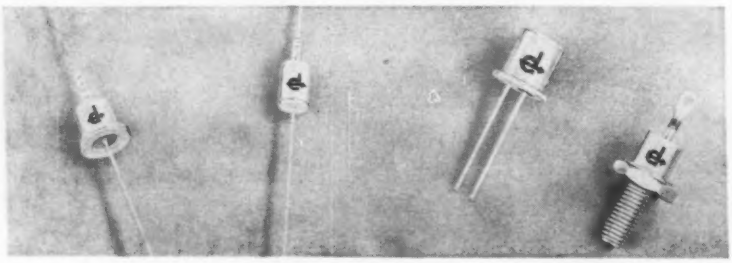
Electrons carrying picture information move toward the anode, where they cross over and are accelerated to focus on a fluorescent screen. The optical image is thus recreated at increased intensity and is then focused on the film and photographed conventionally.

A gating grid, in the path of the electrons flowing toward the anode, serves as the electronic shutter. Shutter speed is limited only by the parameters of the pulse forming circuits. Varying the duration of the pulse provides a range of exposure times.

A fast series of exposures can be taken by deflecting the electron image to different positions on the fluorescent screen and holding the image at each position during exposure. In streak operation the image is swept across the fluorescent screen at a uniform rate. Varying the linear sweep rate varies writing speed.

The camera will be priced at $20,000, from Space Technology Labs. Inc., 8929 S. Sepulveda Blvd., Los Angeles, Calif.

CIRCLE 301 ON READER SERVICE CARD



Zener Diodes

¼ TO 10 W; 6.8 TO 200 V

DIFFUSED JUNCTION zener diodes are rated at ¼, 1, 1.5 and 10 watts and from 6.8 to 200 volts. All units contain single *p-n* junctions formed by controlled diffusion of phosphorus into boron-doped silicon. In normal zener usage these junctions are biased in the reverse direction.

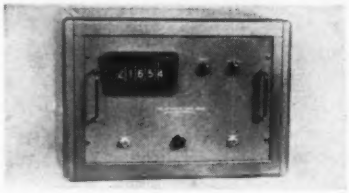
Zener impedance is measured at two points to insure a sharp knee on the breakdown curve and all units are curve-traced to eliminate unstable breakdown or other anomalous effects and are checked 100 percent to electrical parameter limits.

Cases are hermetically sealed with rugged, resistance welded, glass-to-metal seals. External surfaces are corrosion resistant.

Voltage drop is essentially independent of current over a wide range, making these devices effective in regulating d-c voltage, low impedance d-c level changing, biasless clamping, clipping, limiting and surge protection within the bounds of maximum ratings.

Prices are from $1.36 to $15.90 depending upon wattage, tolerance and quantity; availability is from stock to 3 weeks delivery; from Dickson Electronics Corp., 248 Wells Fargo Ave., Scottsdale, Arizona.

CIRCLE 302 ON READER SERVICE CARD

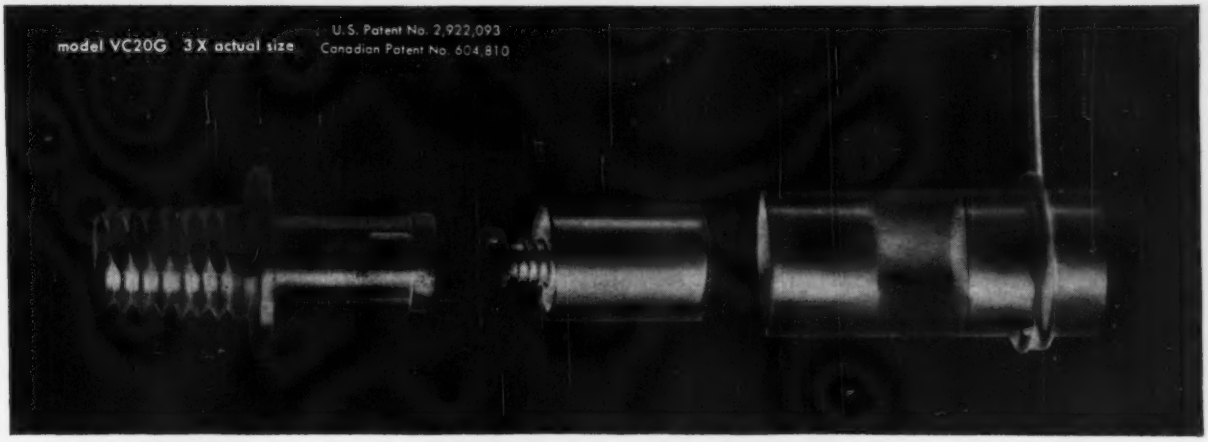


Digital Phase Meter

READS 0.1 DEGREE

METER reads phase angle between two alternating voltages to 0.1 degree. Analog output allows direct plotting of phase characteristic; digital output can operate tape punches, electric typewriters, and printers. Waveform distortion does not affect accuracy since the circuit has no response to even harmonics, and odd harmonics can be isolated by filters.

Phase angle in degrees is represented in four digits; readings are independent of the ratio of signal amplitude; no frequency adjustment is required from 20 cps to 20 Kc; accuracy to ± 0.1 degree (± 1 digit) for symmetrical wave-



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0.8 mmf to 8.5 mmf

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actual size
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model MC601
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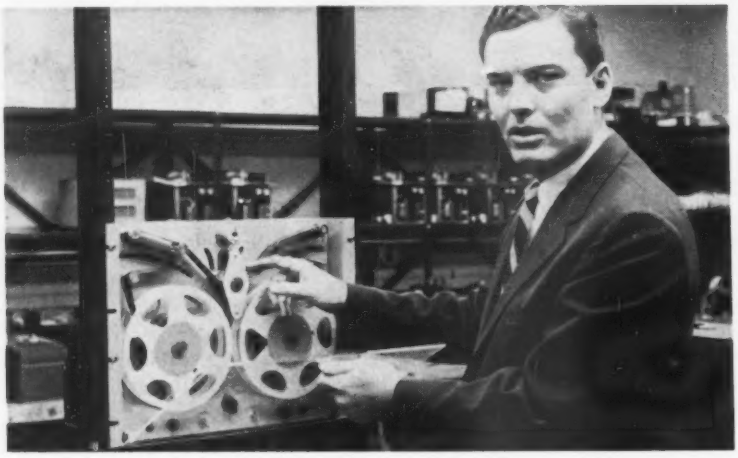
forms of any shape; 0.1 degree resolution regardless of signal amplitude or frequency.

Frequency response with decreasing accuracy may be extended up to 50 Kc and down to 10 cps. The relative accuracy is ±0.1 degree, and the absolute accuracy is ±½ degree from 20 cps up to 20 Kc. Error increases slowly up to ±½ degree relative and 1 degree absolute at 50 Kc and at 10 cps. Input impedance is 1 megohm shunted by 30 pf on both channels. Analog output signal is 0 for 0 degree and −3.6 v for 360 degrees. Price is $3,965; delivery in 2-3 weeks, from Ad-Yu Electronics Lab., Inc., 249 Terhune Ave., Passaic, N. J.

CIRCLE 303 ON READER SERVICE CARD



Tape Reader

USES PRINTED MOTOR

HIGH-SPEED photoelectric tape reader Model 300 R is made by Photocircuits Corp. of Glen Cove, N. Y. The instrument uses a printed motor to advance the paper tape asynchronously at rates up to 300 lines per second without brakes, clutches or pinch rollers. The reels are driven by printed motors which are switched on and off by magnetic circuitry.

Simplicity of design permits a price of $2,520, which includes the reel servos.

CIRCLE 304 ON READER SERVICE CARD

TWT Amplifiers

BROADBAND POWER TO 3 W

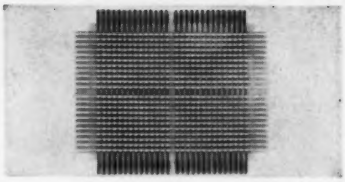
MODEL T601 traveling-wave amplifier covers a frequency range of 2 to 15 Gc and Model T602 covers the range from 10 to 20 Gc.

Both models use new type twt tubes having permanent magnets, thus eliminate heavy solenoids and their associated power supplies; the twt amplifiers are completely self-contained. Included are metered internal power supplies for beam current, beam voltage and grid voltage. The units have broadband characteristics without tuning, and power outputs as high as three watts may be obtained.

Rugged mechanical construction and tubes built to withstand severe environmental conditions make the amplifiers suitable for use under a wide range of conditions.

The amplifiers are 10 inches deep and 10½ inches high. A cabinet for bench use is available as an option. Both models operate from 105-125 volts a-c; from AEL Inc., 121 N. 7th St., Philadelphia, Pa.

CIRCLE 305 ON READER SERVICE CARD



Matrix Circuit Board

PRINTED BOTH SIDES

ALL-PURPOSE matrix printed circuit board lends itself to experimental and prototype work as well as production.

Circuit connections are provided on both sides of the board, with holes provided at each intersection for wiring. The design, in conjunction with the standardized insertion strips, permits crossover, bus-bar and transposition configurations. Unwanted circuit portions can be removed.

Boards can be keyed and are available to fit 22 or 28 contact receptacles on 0.156 centers.

The boards are manufactured by Spec-Tronics, Inc., 13901 Saticoy St., Van Nuys, Calif.

CIRCLE 306 ON READER SERVICE CARD

Small Capacitors

NON-POLAR TANTALUM

A LINE of microminiature tantalum capacitors has been announced by Components Inc. of Biddeford, Maine. Smallest of the capacitors presently available is 0.1 × 0.09 × 0.065 inch; forty capacitors equal the weight of one cigarette.

The Minitan nonpolar solid tantalum capacitor is a full magnitude smaller than the conventional type and yet is stable over a wide range of frequency and temperature. Capacitors now available in production quantities range from 0.001 to 0.0047 μf at 50 v (negative or positive) and from 0.0068 to 0.047 μf at lower voltages. The capacitors operate at rated voltage from −55 to 85 C.

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Semiconductor Kit

WITH 24 ALLOYS

SEMICONDUCTOR alloy kit, priced at $100, with over 25,000 semiconductor preforms, including latest

BINA-VIEW

NEW BINARY DECODING DIGITAL READOUT

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Translates Direct— Coded Binary-to-Decimal and Alpha-numeric

Now, with the new Bina-View, digital readouts take on an added dimension. Here is a readout that operates direct from binary input, has its own retentive memory, and offers one-plane in-line presentation. Realistically priced and designed with the user in mind, it is not to be confused with other readout devices on the market.

The Bina-View Digital Readout fills the long-standing need for a fast, accurate, binary operated display in the fields of digital computers, missile checkout systems, ground support equipment, etc. Its ability to operate within a wide range of binary codes makes it the most versatile readout available today.

Self-Decoding. The new Bina-View Digital Readout accepts any BCD or teletype code up to six bits, does its own translating, and displays the proper character. There are no auxiliary translators, relays, or diodes required.

Low Power. The Bina-View Digital Readout may be operated with as little as ten milliwatts per bit of signal power. It may be connected directly into computers and other electronic equipment.

Character Storage. The Bina-View Digital Readout will continue to display the last character entered after the signal input power has been removed.

Memory and Verification (Optional). When required, contact closures may be provided for verification that the input signals have been properly accepted.

Practical. The Bina-View Digital Readout offers clear distinct characters, high even brightness, and wide viewing angle. Extremely durable and vibration-free, it is designed for thousands of hours of trouble-free operation.

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Typical circuit applications for Magnetic Modulators are algebraic addition, subtraction, multiplying, raising to a power, controlling amplifier gains, mechanical chopper replacement in DC to fundamental frequency conversion, filtering and low signal level amplification.

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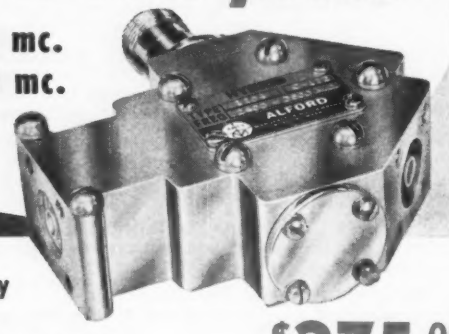


- Balance inherently independent of frequency
- Handles high power
- Constant coupling in both magnitude and phase over the frequency range with equal loads

$275.00

Type	Frequency range	Residual unbalance (isolation)	Price
1102	1600-2400 mc	greater than - 40 db	$275.00
1104	2400-3600 mc	greater than - 34 db	$275.00

Type 1104-S Hybrid for use over the frequency range 2200-5000 megacycles is also available. It has the same low residual unbalance but a higher SWR.

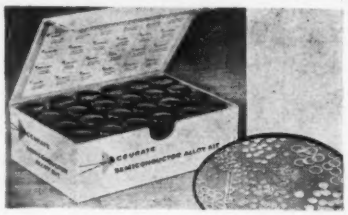
Write for complete information on AMCI Transmission Line Hybrids

AMCI
ANTENNA SYSTEMS – COMPONENTS – AIR NAVIGATION AIDS – INSTRUMENTS
ALFORD *Manufacturing Company*
299 ATLANTIC AVE., BOSTON, MASS

CIRCLE 156 ON READER SERVICE CARD

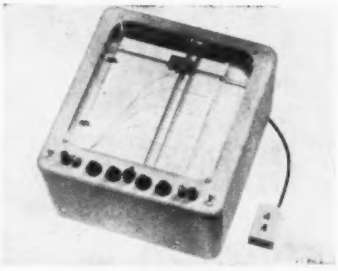
alloys, is available from Accurate Specialties Co., Inc., 345 Lodi Street, Hackensack, N. J.

Kit Z-100 contains semiconductor disks, washers, and spheres. Clad metals such as indium-clad aluminum are included. The kit contains 24 different alloys for use in both germanium and silicon diodes, rectifiers, and transistors. Other alloys include tin-antimony, lead-silver, indium-germanium, tin-lead-antimony, 99.999 percent pure indium, aluminum-boron, etc.



All alloys are packaged in argon for maximum shelf life. Further, all alloys and clad metals have been documented to permit manufacture to the same specification in volume at a later date.

CIRCLE 308 ON READER SERVICE CARD



X-Y Recorder

ELECTRIC PEN LIFTER

HOUSTON INSTRUMENT CORP., P. O. Box 22234, Houston 27, Texas. Model HR-93 X-Y recorder has a simple and rugged electric pen lift mechanism allowing point plotting, family curve tracing and rapid non-recording pen indexing. The pen lifter can be operated either with the hand-held manual control box or can be tied into the test circuit for automatic operation. Each axis contains its own power supply, attenuator and zero control and is independent both mechanically and electrically of the other. Amplifiers are interchangeable and available in 10 mv/in. and 1 mv/in. sensitivity for either or both axes. Ac-

curacy is ½ percent with 7½ in./per sec pen speed on both axes. Price: $670 to $770.

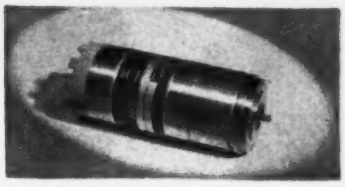
CIRCLE 309 ON READER SERVICE CARD

Ferrite Storage Core

—55 TO +100 C RANGE

AMPEX COMPUTER PRODUCTS CO., Advanced Memory Division, P. O. Box 329, Culver City, Calif., has available a ferrite storage core, the XCWT 508-10, which will operate without current or temperature compensation over a temperature range of −55 to +100 C. Designed for coincident current memory operation this 0.050 in. core is now available in experimental quantities.

CIRCLE 310 ON READER SERVICE CARD

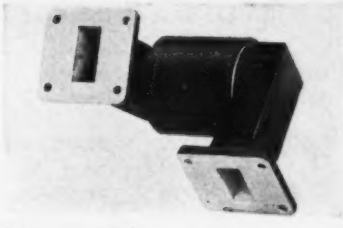


Motor Generator

PRECISION UNIT

KEARFOTT DIVISION, General Precision, Inc., 1150 McBride Ave., Little Falls, N. J. The T870-36B integrating motor generator is designed for high-accuracy, high-response systems. Temperature compensated to insure low output sensitivity to varying ambient temperature, it features excellent linearity (0.05 percent from 0 to 3,600 rpm) and low rotor moment of inertia (10 gm cm²).

CIRCLE 311 ON READER SERVICE CARD

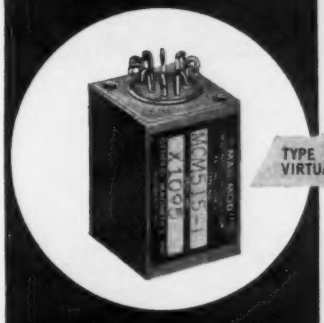


Rotary Joints

U-STYLE

MICROWAVE DEVELOPMENT LABORATORIES, INC., 92 Broad St., Babson Park, 57, Wellesley, Mass. Fourteen different U-style waveguide

Another reliable GENERAL MAGNETICS "MAG MOD" Miniature



Continuous Accuracy within ± 5% of Theoretical Product over the entire Ambient Temperature Range

NEW **MAGNETIC** *multiplying* **MODULATOR**

Specifically designed to deliver an analog output voltage which is the continuous product of two variable input voltages. One of these is an excitation voltage which varies over a pre-determined range; in this case, 0 to 1 VRMS 400 cycles per second. The other signal is a DC current which varies between 0 and ± 400 μa. The output voltage is 400 cycles AC, and is always in phase or 180° out of phase with the variable excitation or fixed reference, i.e., in phase when the variable amplitude DC signal is positive, and 180° out of phase when the DC signal is negative.

TYPE MCM 515-1 SHOWN ACTUAL SIZE. COMPLETELY RUGGEDIZED, VIRTUALLY SHOCK AND VIBRATION PROOF. WEIGHS ONLY ONE OZ.

THERE IS NO SUBSTITUTE FOR RELIABILITY!

Specify "MAG MOD" miniature components for infinite life, faster response time, negligible hysteresis and extreme stability. Call or write for new Brochure 102 on "MAG MOD" Miniaturized Magnetic Modulators and Magnetic Multiplying Modulators.

General Magnetics • Inc

135 BLOOMFIELD AVENUE
BLOOMFIELD, NEW JERSEY
Telephone: Pilgrim 8-2400

CIRCLE 218 ON READER SERVICE CARD

HERE'S A TWIST.....

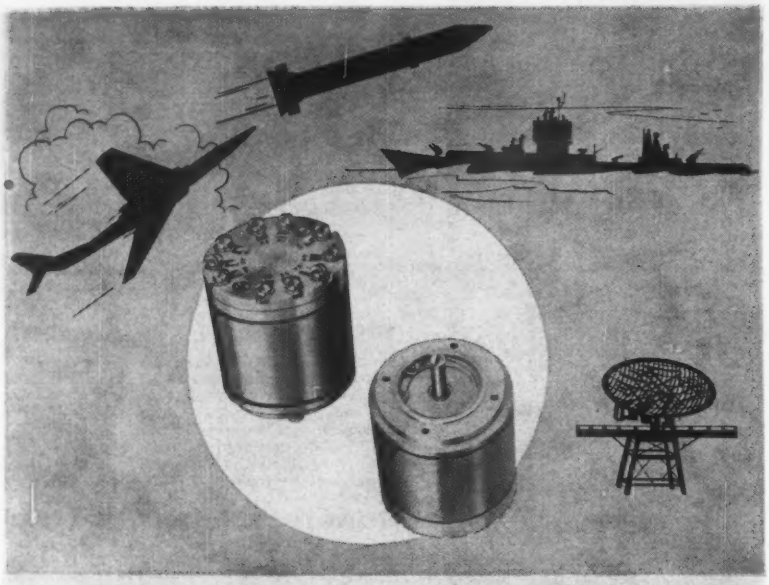
GIANNINI CONTROLS' HIGH TORQUE PANCAKE MOTOR FOR DIRECT DRIVE APPLICATIONS

Resolution a problem? Need lots of torque in a flat package? For stable platforms, two-axis gyros, antenna drives, integrating accelerometers, and many other servo applications, nothing can beat these Giannini Controls' direct-drive Torque Motors as prime movers. DC types feature high electrical and mechanical response **at the output shaft.** AC types feature large internal bores. Pancake configuration gives flexibility in installation and high torque efficiency in a relatively small volume. Send for Data Sheet 110

ANOTHER SERVO COMPONENT FROM GIANNINI CONTROLS

Giannini Controls Corporation
A NAME TO PLAN WITH
1600 South Mountain Avenue, Duarte, California
SERVO COMPONENTS & SYSTEMS • AIR DATA INSTRUMENTS & SYSTEMS
INERTIAL INSTRUMENTS & SYSTEMS
Sales engineering offices: Glendale • Caldwell, N. J. • Pasadena • Denver • Palo Alto • Seattle • New York
Chicago • Dayton • Washington, D. C.
GCC 1-21

REPORT



Now available in production volume:

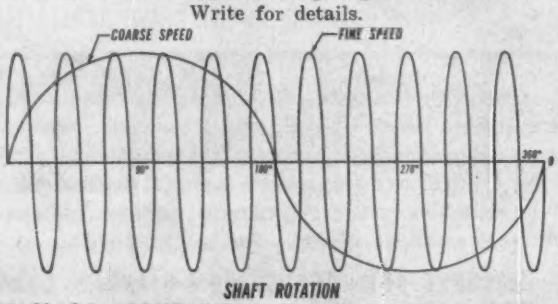
BENDIX AUTOSYN® SYNCHROS AND SYSTEMS with 30-SECOND ACCURACY

The Bendix two-speed Autosyn synchro was developed to meet the need for accurate data transmission with maximum system simplicity. Two electrical outputs are produced from the Autosyn single shaft, eliminating both inaccuracies of two-speed gearing and the installation and maintenance costs of an additional unit.

Autosyn units can be supplied with leads or terminal boards. Units can be used back-to-back or can be coupled with mechanical two-speed transmitters or control transformers. They measure only 2.34" in length by 1.75" in diameter.

Other features: **Accuracy unaffected by thermal or mechanical stress—Adaptability to gyro pick-off—Elimination of gear error of mechanical two-speed system—High signal-to-null ratio.**

Write for details.



SHAFT ROTATION

EXAMPLES OF APPLICATIONS: Fire Control Systems—Navigation Computers—Inertial Guidance Systems—Radar Antenna Tracking

Eclipse-Pioneer Division
Teterboro, N. J.

Bendix

District Offices: Burbank, and San Francisco, Calif.; Seattle, Wash.; Dayton, Ohio; and Washington, D. C.
Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

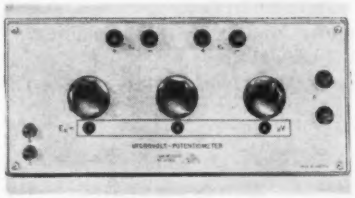
rotary joints are now available in stock designs. They may be obtained in WR90 EIA waveguide sizes for operating ranges of 8,500 to 9,600 Mc; in WR112 sizes spanning different ranges between 7,000 and 10,000 Mc; in WR137 size for 5,400 to 5,900 Mc; and in WR187 sizes covering different ranges between 4,250 and 6,000 Mc. They may be ordered in either aluminum or copper alloy in a variety of standard finishes. Several of the standard non-pressurized U-joints are also available in 30-psig pressurized models.

CIRCLE 312 ON READER SERVICE CARD

Snap-Action Switch
FOR PANEL MOUNTING

MILLI-SWITCH CORP., Gladwyne, Pa., announces the B-PB3-2 miniature push button switch for panel mounting. The snap-action switch provides a positive feel of switch operation with almost simultaneous switching action. It conforms to MIL-S-6743, Military Part 25085-1. It weighs 6 oz and requires an operating force of 21 oz.

CIRCLE 313 ON READER SERVICE CARD

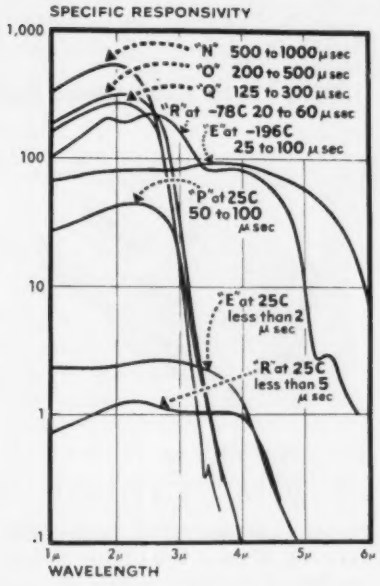


Potentiometer
MICROVOLT TYPE

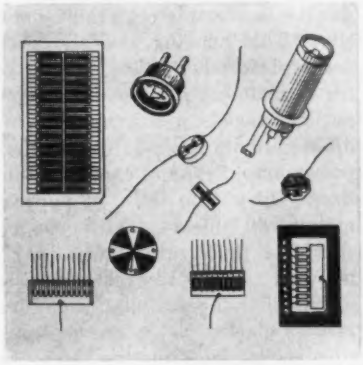
PHYSICS RESEARCH LABORATORIES, P. O. Box 555, Hempstead, N. Y. The Goerz model AE5075 microvolt potentiometer has a range from 0-1,110 μv with a resistance of 100 ohms per mv. Pot current is thus 10 μv and the power source used is a built-in saturated standard cell. This current may be drawn from a standard cell without damage for long periods of time. The

KODAK EKTRON DETECTORS

-for the 1μ to 6μ infrared



a wide-open choice in spectral responsivity and time constant



a wide-open choice of physical forms —large, small, complex shapes, multiple arrays, "immersed," Dewar-housed—ingenuity is the only limit, almost

For more precise explanations and a price list of off-the-shelf Kodak Ektron Detectors (or to see if we can build a complete infrared system for you), write—

EASTMAN KODAK COMPANY

Apparatus and Optical Division

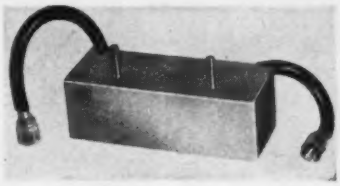
Rochester 4, N.Y.

Kodak TRADE MARK

CIRCLE 217 ON READER SERVICE CARD

AE5075 is designed for comparing two voltages that are within 0.1 percent of each other to within 1 μv directly, or to within a fraction of a microvolt by interpolation on the galvanometer.

CIRCLE 314 ON READER SERVICE CARD



I-F Filter

FOR MOBILE RADIO

ESC ELECTRONICS CORP., 534 Bergen Blvd., Palisades Park, N.J., announces the model F-124 rugged mobile radio i-f filter. Center frequency is 455 Kc ± 1 Kc; insertion loss, 23 db (max) bandwidth at 6 db, 10.5 Kc; at 60 db, 31 Kc; maximum ripple, 0.5 db within the pass band; dimensions, 3¼ in. by 1⅛ in. by 1⅛ in. Connections are coaxial cables.

CIRCLE 315 ON READER SERVICE CARD

Sweeping Power Supply

VERSATILE UNIT

ALFRED ELECTRONICS, 897 Commercial St., Palo Alto, Calif. Model 610C is a sweeping power supply for operation of voltage tuned magnetrons. It provides electronically swept operation either linear with time with repetition rates of 10 cps to 0.01 cps or nonlinearly at 60 cps. Sweep voltage is available over the whole range or any part of the range. The unit may also be externally swept. Key specifications: anode (relative to chassis) −250 to −2,500 v, sweep increases linearly with time; 0.02 percent maximum peak to peak ripple and noise;

REPORT

NEW 2-SPEED "PANCAKE" SYNCHRO TRANSMITTER

Resists stresses and temperature extremes

This compact, two-speed "pancake" synchro transmitter consistently exhibits an accuracy within thirty seconds of arc under dimensional stresses and wide temperature variations. The same order of accuracy is maintained when the transmitter is used back-to-back with a conventional two-speed control transformer. The synchros are operable from −55°C. to +200°C. They are logical replacements for existing mechanical two-speed transmitters. Their bantam weight (5 oz.) and small size (2.685" O.D. x 1.002" I.D. x 0.562" thick) suits them ideally to vertical gyro gimbals and other assemblies where size and weight are critical factors. Write for complete information.

Manufacturers of

GYROS • ROTATING COMPONENTS
RADAR DEVICES • INSTRUMENTATION
PACKAGED COMPONENTS

Eclipse-Pioneer Division

THE Bendix CORPORATION

Teterboro, N. J.

Measurements engineer with General Electric Locomotive and Car Equipment Department checks operation of PI recorder in locomotive cab.

PI Tape Recorder rides the rails– writes 14-track travel report

Even in the pitching, rolling cab of an 1800-horsepower diesel-electric locomotive, it's an easy task for a PI instrumentation magnetic tape recorder to gather data with laboratory accuracy. In special tests recently run by General Electric's Locomotive and Car Equipment Department, their PI 14-track tape recorder was used to measure such parameters as shaft torque, motor-mount movement, strain information, vibration, speed and motor current data.

Magnetic tape was chosen for the job because it permits automatic frequency analysis and analog computer processing of quasi-random data. Such data, when recorded by conventional oscillographic methods, may be extremely difficult and time consuming, if not impossible, to analyze.

Precision π Recorder shown in standard shock mounting

For this and other mobile or airborne applications, PI all-solid-state tape recorders offer many unusual advantages which we'd like to tell you about. Drop us a note today, or phone your local Precision representative.

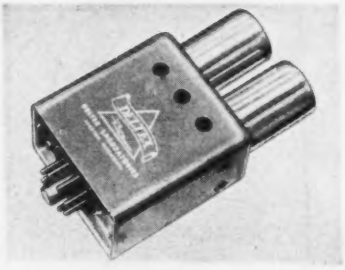
PRECISION INSTRUMENT COMPANY
1011 Commercial Street • San Carlos, California
Phone: LYtell 1-4441 • TWX: SCAR BEL 30

REPRESENTATIVES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

160 CIRCLE 160 ON READER SERVICE CARD

control electrode (relative to cathode) 0 to 900 v, 0 to 5 ma, 0.02 percent peak to peak ripple above 50 v; amplitude modulation: external, d-c operation; internal, 800 to 1200 cps square wave; filament supply, 0 to 6 v d-c at 0 to 4 amperes. Price is $1,690.

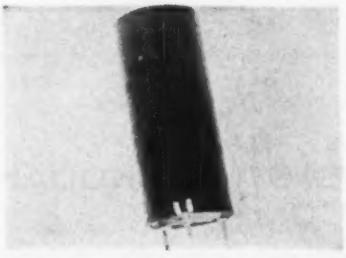
CIRCLE 316 ON READER SERVICE CARD



D-C Amplifiers
& CHOPPER STABILIZER

DELTEX LABORATORIES, Box 2666, Jackson, Miss. A line of operational amplifiers exhibits improved temperature characteristics and isolation from electromagnetic radiation due to its complete metallic enclosure. This housing also allows the use of hold-down studs, if desired, for mechanical rigidity. Four compatible models are available: medium gain and high gain amplifiers, power amplifier, and chopper stabilizer. Open loop gain to approximately 30,000 d-c, with chopper stabilized drift rate of less than 1 mv per day. Interchangeability with other operational amplifiers now on market makes conversion to this economical line as simple as replacing a tube.

CIRCLE 317 ON READER SERVICE CARD



Wide Range Capacitor
ELECTROLYTIC

CORNELL-DUBILIER ELECTRONICS DIVISION, Federal Pacific Electric Co., 333 Hamilton Ave., South Plainfield, N.J. The ESS-7515 is a com-

pact, cardboard-sleeved, plug-in type electrolytic capacitor. It provides an exact electrical and mechanical replacement for 8 original standard 150 wvdc capacitors commonly used in printed circuit radio and tv receivers. These are: 50-30 μf, 70-30 μf, 75-30 μf, 60-40 μf, 80-40 μf, 50-50 μf, 70-50 μf, and 80-50 μf.

CIRCLE 318 ON READER SERVICE CARD

Digital Clock

TRANSISTORIZED

DATEX CORP., 1307 South Myrtle Ave., Monrovia, Calif. The DC-116 digital clock operates from a 100-Kc input and provides an output in hours, minutes and seconds on a 24-hr basis. It contains a counter and a frequency divider. Circuitry is on standard Datex CM-100 modules, mounted in a standard chassis, 7 in. by 19 in. by 11 in. A record-rate interval control enables a pulse to be generated for system control at preset intervals. The 24-hr time output is suitable for driving a teletypewriter high speed BRPE tape punch and may be either decimal or binary coded decimal form.

CIRCLE 319 ON READER SERVICE CARD

Linear Motion Pots

PRECISION UNITS

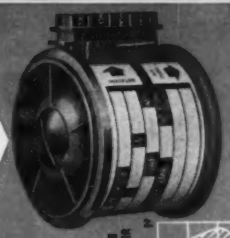
MARKITE CORP., 155 Waverly Place, New York 14, N. Y., offers a new series of ½-in. diameter linear-motion potentiometers for servo control systems and instrumentation transducers in aircraft and missiles. The units are applicable in designs with inherent space limitations and high performance, continuous-duty requirements. Types 3239 and 3209 are designed to full MIL environmental specs. They offer independent linearities of ±0.5 percent or better, and are available with element resistances

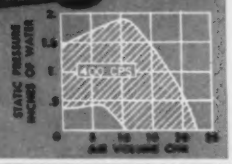
AXIMAX MINIATURE 400CPS FANS

AXIMAX 1

1 13/32" 4 OZS.

12 to 23 CFM 11,400 to 22,500 RPM



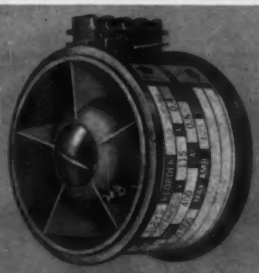


- Extremely compact and lightweight—1½" x 1¾", 4 ozs.
- 115 or 200 VAC, 1 ϕ or 3 ϕ, 400 cps.
- Airflow reversible.
- Built to Military Specifications.

AXIMAX 2

1 15/32" 4½ OZS.

24 to 60 CFM 8,000 to 20,000 RPM

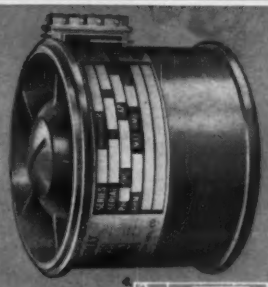


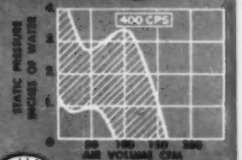
- Size: 2" x 1½". Weight: 4½ ozs.
- 115 or 200 VAC. 320 through 1600 cps. 1 ϕ or 3 ϕ
- High altitude (Altivar) ⊛ and high density designs available.
- Airflow reversible.
- Built to Military Specifications.

AXIMAX 3

2 5/16" 14 OZS.

70 to 165 CFM 9,000 to 22,000 RPM





- Size: 3¼" x 2⅜". Weight: 14 ozs.
- 115 or 200 VAC. 400 and other cps. 1 ϕ or 3 ϕ.
- High altitude (Altivar) ⊛ and high density designs available.
- Airflow reversible.
- Built to Military Specifications.

Appropriate cam-locking mounting clamps are available from Rotron for servo-mount Aximax fans.

Write for Complete Technical Details, or Submit Your Cooling Problems for Recommendations...

ROTRON

ROTRON MANUFACTURING CO., INC.
WOODSTOCK, NEW YORK

"AXIMAX" is a registered trademark of Rotron Mfg. Co., Inc.

ONLY MASSA RECORDERS COMBINE ALL

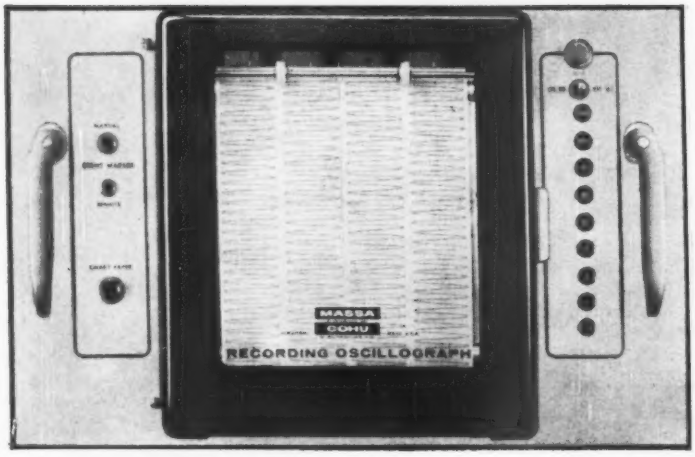
4

HIGH-SPEED

RECTILINEAR

INK WRITING

PLUG-IN PREAMPLIFIERS



MODEL
BSA-450
4 CHANNEL
40 MM

All of the exclusive features incorporated in previous Massa Recorders, including the *New Controlled Linearity Oscillographs*, are incorporated in the NEW 4 CHANNEL RECORDING SYSTEM. The all new front design greatly simplifies chart paper loading and permits full instant view of pen action and recorded signals on 7 x 10 writing table. Improved tracking, instant loading, accurate performance, are some of the novel features included in the new design.

Other features: 40 mm (full scale) Oscillographs, DC to 120 cps • Ink or electric rectilinear writing • 18 chart speeds, from 0.5 cm/hr to 200mm/sec • Event Marker • Automatic warning light for low chart indicator.

The new 4 channel recorder is now available in complete recording systems including individual transistorized driver amplifiers and power supplies for each channel, and a choice of interchangeable plug-in preamplifiers including DC, AC, Carrier and Chopper.

MASSA
A DIVISION OF
COHU
ELECTRONICS, INC.
275 LINCOLN STREET
HINGHAM, MASSACHUSETTS

OTHER MASSA PRODUCTS

COMPLETE LINE OF
MULTICHANNEL AND PORTABLE RECORDING SYSTEMS

ACCELEROMETERS
HYDROPHONES
MICROPHONES
AMPLIFIERS
SONAR TRANSDUCERS

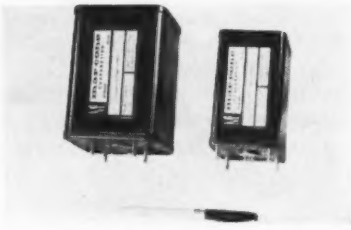
ranging from 1,000 to 20,000 ohms. Type 3239 has a shaft stroke length of 1.587 in., and type 3209, a shaft stroke length of 0.600 in. This series permits coaxial mounting to meet design configurations found in pneumatic and hydraulic systems.

CIRCLE 320 ON READER SERVICE CARD

Epoxy Curing Agent
AND DEMINERALIZER

HARCHEM DIVISION, Wallace & Tiernan Inc., 25 Main St., Belleville 9, N. J., announces Harcure A, a linear polymeric anhydride that functions as a flexibilizer as well as curing agent for epoxy resins. It imparts excellent thermal shock properties as well as good high temperature electrical properties to cured epoxy recipes. Harcure A can be formulated with liquid or solid epoxy resins into a single component system with prolonged shelf life at room temperature. Data and samples are available.

CIRCLE 321 ON READER SERVICE CARD

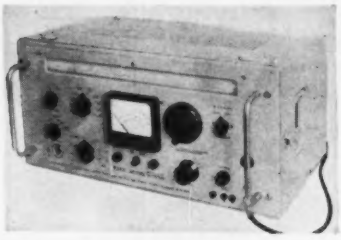


Power Supplies
TRANSISTORIZED

MAR-CONE CORP., 44 Winn St., Woburn, Mass., announces a new series of small, low-cost, plug-in, transistorized power supplies to provide a well regulated power source suitable for strain gages and other uses requiring a stable d-c source as well as for general purposes. Voltage regulation is better than 0.01 percent for line variations of 100 to 130 v, and load regulation is 0.3 percent. Standard models are available with output voltages of 12, 18, and 24 v with corresponding output currents from 400 ma to 200 ma for the smaller model 9160 series and 1.2 amp to 0.600 amp for the larger model 9360 series. Ripple is less than 0.05 percent, and output isolation is 1,000 megohms minimum. Units are hermetically sealed. Small preci-

sion adjustments of output voltage can be made by an external potentiometer.

CIRCLE 322 ON READER SERVICE CARD



Microvoltmeter
SELECTIVE TYPE

ROHDE & SCHWARZ, 111 Lexington Ave., Passaic, N. J., announces type USVH highly sensitive, selective microvoltmeter for the frequency range from 10 Kc to 30 Mc. It employs a sensitive superheterodyne receiver whose output voltage is read by a diode voltmeter. A switch permits selection of any of the conventional input impedances. Among many typical applications of the microvoltmeter are: selective attenuation and frequency-response measurements on four-terminal networks, up to 140 db; selective frequency-response measurements on amplifiers or filters within their pass bands; and measurement of the r-f distortion of long, medium and short-wave transmitters, with values as low as 0.1 percent or 60 db.

CIRCLE 323 ON READER SERVICE CARD

Electronic Generator
HIGH-POWER

COMMUNICATION MEASUREMENTS LABORATORY, INC., 350 Leland Ave., Plainfield, N.J. Model M 1435 D

TIME TEAM

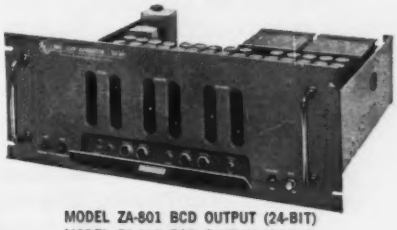
EECO'S ALL-STAR LINEUP OF TIME CODE GENERATORS COVERS ALL THESE BASES

From missile base to basic research, in launching-area heat or Dew-Line cold, Electronic Engineering Company answers your project's time code needs with these outstanding time code generators . . . for binary or BCD readouts, coded for Atlantic Missile Range, Eglin Test Range or the new Inter-Range Instrumentation Group (IRIG) format proposed for world-wide use in satellite tracking.

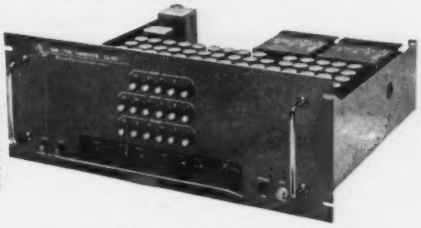
All EECo time code generators can be used with oscillographs, strip chart recorders, magnetic tape or for driving neon flash lamp amplifiers . . . for time-correlation of data recorded by different instruments at one or more sites. All have advance-retard controls for synchronizing internal 1 pps to WWV.

MORE ACCURACY PER DOLLAR with the time code generators shown at right. Both time of day code output (24-hour recycling) and any 2 of 8 pulse rates. Time-correlate data to within ±1 millisecond at a cost of only $7,500 for the ZA-801, $7,000 for the ZA-802. Frequency stability: 3 parts in 10^8 per day.

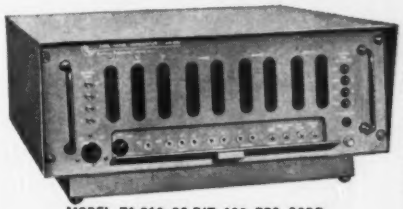
Compact...solid-state plug-in circuits . . . sized for standard rack mounting. Complete unit, including power supply, 7" x 19" x 17".



MODEL ZA-801 BCD OUTPUT (24-BIT)
MODEL ZA-803 BCD OUTPUT (20-BIT)



MODEL ZA-802 BINARY OUTPUT (17-BIT)



MODEL ZA-810 36-BIT 100 PPS CODE
ALSO MODEL ZA-810-M1
23-BIT 2 PPS CODE (IRIG TYPE C)

GENERATES NEW IRIG FORMAT Model ZA-810 (left) and Model ZA-810-M1, solid-state time code generators, use proposed Inter-Range Instrumentation Group formats.

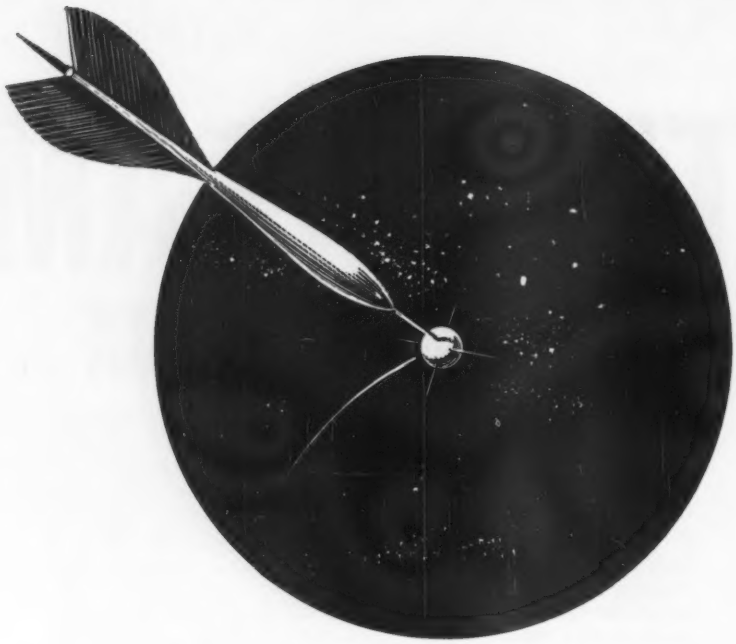
Both generators have same high accuracy as ZA-801 and 802. Packaged plug-in circuits. Complete unit 7" x 19" x 18". Weight only 35 pounds. Price of either model: $10,100.

WRITE FOR TIME CODE GENERATOR FILE 301.
TIMING SYSTEM DESIGN CONSULTATION ON REQUEST.

Electronic Engineering Company *of California*

1601 East Chestnut Avenue • Santa Ana, California • Kimberly 7-5501 • TWX: Santa Ana Cal 5263
MISSILE & AIRCRAFT RANGE INSTRUMENTATION • DIGITAL DATA PROCESSING SYSTEMS • TIMING SYSTEM • COMPUTER LANGUAGE TRANSLATORS • SPECIAL ELECTRONIC EQUIPMENT
EE 6-12

CIRCLE 163 ON READER SERVICE CARD



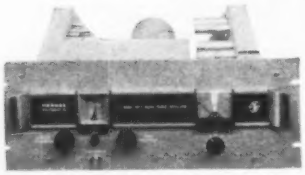
Pin-pointing the time dimension

To establish precise orbital parameters, Hermes Ultra Stable Oscillators, Model 101C, are being used as frequency standards in timing systems for Transit, Project Mercury, and Minitrack programs, and by many Missile Tracking Stations around the world.

These Hermes Ultra Stable Oscillators are of such high stability that global time synchronization accuracies in the *order of microseconds* are now possible. Numerous reports have been received stating that many of these units exhibit average drift rates of 1 part in 10^{10} per day . . . in some instances, less than 1 part in 10^{10} per week!

The Hermes Ultra Stable Oscillator, Model 101C, is now in its fifth year of production. Every unit is pre-aged at the factory until it exhibits a frequency stability of better than its guaranteed stability of 5 parts in 10^{10} per day. Hermes Ultra Stable Oscillators are *available from stock.*

Write for Technical Bulletin USO



Hermes USO, Model 101C. Also available . . . Regenerative Frequency Dividers providing outputs at 100kc, 10kc, and 1kc, and Frequency Multipliers providing phase stable outputs of 10Mc and 100Mc.

Guaranteed stability 5 parts in 10^{10} per day

Hermes
ELECTRONICS CO.
75 CAMBRIDGE PARKWAY, CAMBRIDGE 42, MASS.
A DIVISION OF Itek

164 CIRCLE 164 ON READER SERVICE CARD

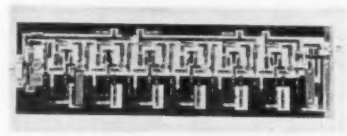
a-c electronic generator has output of 2,000 v-a and can be integrated into two and three-phase systems. Principal specifications are: frequency range, 50 to 2,000 cps; frequency stability, ±0.001 percent; voltage regulation, ±1.0 percent; voltage stability, ±0.25 percent; distortion, less than 1.0 percent; weight, 1,050 lb.

CIRCLE 324 ON READER SERVICE CARD

Magnetic Amplifiers
FOR SERVO MOTORS

AIRPAX ELECTRONICS INC., Fort Lauderdale, Fla., announces magnetic servo amplifiers designed to drive instrument type two-phase servo motors, controlling the current to both phases, thereby greatly reducing the standby power drawn by equipments employing them. Input is d-c polarity reversible; output is a-c phase reversible. The combined power gain of this unit used with an Airpax preamplifier is 8×10^6. As a result, the input may be as low as 75 μa for maximum output to the motor. Delivery is 3 to 4 weeks. Priced at $93 each in quantities 1-6.

CIRCLE 325 ON READER SERVICE CARD



Video Amplifier
LOGARITHMIC

THE W. L. MAXSON CORP., 475 Tenth Ave., New York 18, N. Y. Type LVT-1 is a fully transistorized logarithmic video amplifier. When used in conjunction with a crystal detector mount, results in a crystal video receiver with a logarithmic input-output relationship. A 60 db

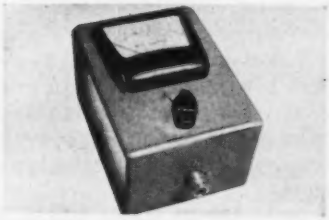
dynamic range is achieved, with a bandwidth of 4 Mc. Individual stage feedback permits shaping of transfer characteristic. Amplifier pairs matched to within ± 1.5 db can be supplied as a special item. For applications where signal levels are sufficiently high, such as in countermeasures or beacon environments, a considerable saving in both cost and size of receiver equipment is achieved by use of the LVT-1.

CIRCLE 326 ON READER SERVICE CARD

Capacitors
MICROMINIATURE

GULTON INDUSTRIES, INC., 212 Durham Ave., Metuchen, N. J., has developed a complete line of microminiature temperature compensating capacitors. They are rated at 75 v d-c and are available in temperature coefficients from P100 through N750 and N1400 through N5600. Tolerances as tight as ±10 ppm/deg C are available in standard or non-standard coefficients. Capacitors meet or exceed requirements of MIL-C-20C.

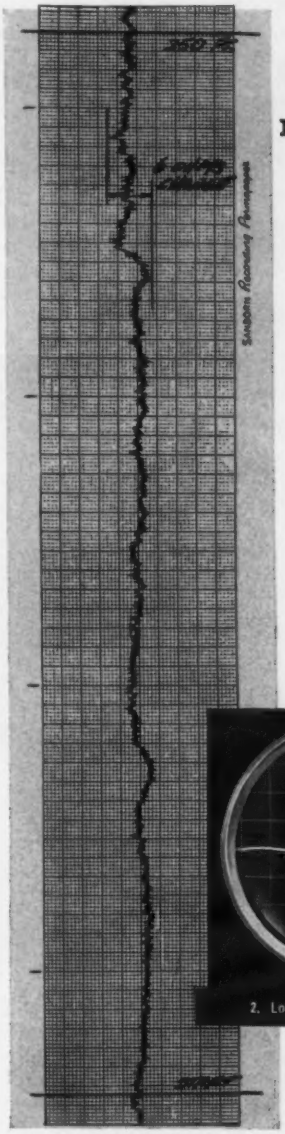
CIRCLE 327 ON READER SERVICE CARD



R-F Power Meters
BROAD BAND

ELECTRO IMPULSE LABORATORY, INC., 208 River St., Red Bank, N.J. announces three additions to its line of low power r-f power meters. Measuring from 0.2 to 700 Mc, they include model PM-4, 150 and 600 mw full scale; PM-5, 500 and 1,500 mw full scale and PM-6, 1.5-6 w full scale. Units are of the absorption type consisting of an air-cooled, coaxial load resistor and a voltmeter calibrated to read watts. They are suitable for use as field or laboratory test instruments, are completely shielded and non-radiating, permitting transmitter testing and adjustment without interference. No correction curve is neces-

How to produce better
POTENTIOMETERS
without increasing costs



1. Closer Linearity of Wire Resistance

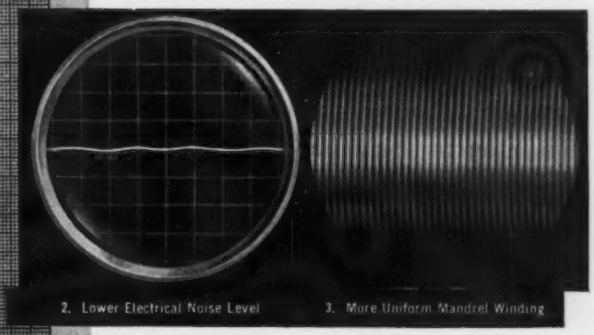
Use Hoskins
Chromel-R
Premium Potentiometer Grade Wire

a new custom-quality nickel-chromium alloy especially developed, processed and controlled to assure you of:

1 Closer independent linearity, with maximum total deviation continuously controlled to within .012% over any 250 feet of wire.

2 Lower electrical noise level, unconditionally guaranteed to be less than 40 ohms of E.N.R. when received at your plant.

3 Greater efficiency in winding mandrels—with more uniform spacing between turns—due to its superior wire roundness.



2. Lower Electrical Noise Level 3. More Uniform Mandrel Winding

If you make POTENTIOMETERS this wire is right for you!

It's premium in quality but not in price. And sample spools plus complete technical data are available now to potentiometer manufacturers for immediate testing and evaluation. Your request on company letterhead will receive our prompt attention.

HOSKINS MANUFACTURING COMPANY
4445 Lawton Avenue • Detroit 8, Michigan
In Canada: Hoskins Alloys of Canada, Ltd., Toronto, Ontario
Producers of Custom-Quality Resistance, Resistor and Thermo-electric Alloy Since 1908

D-C AMPLIFIER EVALUATION *number 1 in a series*

AMPLIFIER NOISE

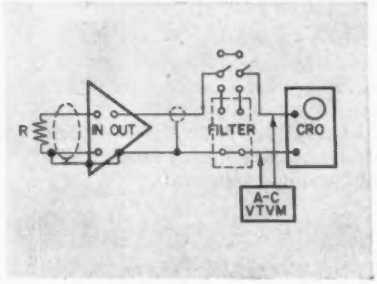
Accuracy is the basic objective in amplifier selection. When evaluating amplifiers for specific applications all errors must be considered. One such error, the noise level, determines the ultimate accuracy of the amplifier since the smallest observable signal cannot be less than the noise level. However, noise outside the frequency response range of the amplifier load can be filtered out or ignored with such read-out devices as galvanometer oscillographs.

Noise in an amplifier is any voltage component appearing at the output that has no counterpart in the input signal. Usually only the a-c component of the output is termed noise. The d-c component is called zero drift and its evaluation will be covered in another of this series.

Internally generated a-c components must be evaluated as to amplitude and frequency range. Noise may be divided into two general classes and measured as described below. (a) *Random voltages* of a broad band nature arising from thermal agitation in resistors and random tube or transistor noise . . . measurements on a peak-to-peak basis are often 10 times or more larger than the measured rms value over the same frequency band. (b) *Narrow band voltages* induced within the amplifier by line voltage or chopper excitation . . . these voltages are generally sinusoidal so that peak-to-peak values are only about 2.8 times larger than the measured rms values.

Testing amplifiers for noise

If the input signal is zero, any voltage components detected at the



amplifier output can be identified as noise. A standard technique for measuring noise is shown.

The oscilloscope measures the peak-to-peak values, the VTVM in rms values. Equivalent input noise (eq. in) is the measured noise divided by the amplifier gain. For details write for Bulletin BE AN121.

Noise less than 0.04%

With a full scale input signal of 10 mv, Honeywell's AccuData III Amplifier has a wide band (0-100 kc) noise specification of 4 μv (eq. in) and a peak-to-peak noise over a 0-10 cps band of 4 μv (eq. in) . . . less than 0.04% of full scale!

The AccuData III, a wide band differential input d-c amplifier with all transistor design, is especially useful for driving analog-to-digital converters, f-m magnetic tape systems and high speed oscillographs where low level signals such as thermocouple, strain gage and similar transducer outputs are to be accurately measured. Write for Bulletin BS-DISA-3 to Minneapolis-Honeywell, Boston Division, Dept. 7, 40 Life Street, Boston 35, Mass.

Honeywell
First in Control
SINCE 1885

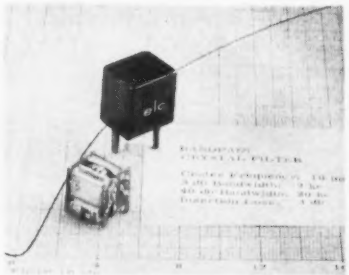
sary to cover the frequency range. Accuracy is ±5 percent. Price, $95 each.

CIRCLE 328 ON READER SERVICE CARD

Average Power Meter
PRECISION UNIT

SPERRY MICROWAVE ELECTRONICS CO., P.O. Box 1828, Clearwater, Fla. The Microline model 31A1, an average power meter for lab, factory or field use when precision measurements of power are necessary, is accurate to 3 percent of full scale reading. It can be used to measure pulsed or c-w power of radar, radio, tv, microwave and microwave relay equipment components. The frequency coverage is limited only by the characteristics of the bolometer and mount used. Model 31A1 measures power levels up to 10 mw directly; this range can be extended as required by using directional couplers and/or calibrated attenuators.

CIRCLE 329 ON READER SERVICE CARD

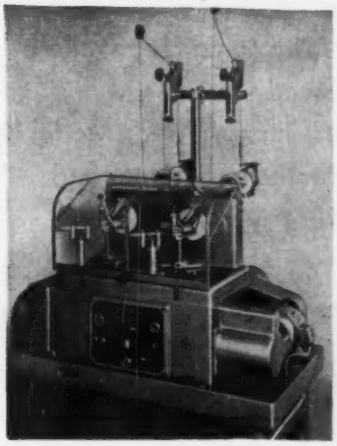


Crystal Filter
FOR MISSILE USE

ELECTRONIC LABORATORIES CORP., 4221 Spencer St., Torrance, Calif., has developed a "minified" 10-Mc bandpass filter for missiles. Having less than a half cu-in. volume,

the device contains two quartz crystals and a number of components. With a center frequency of 10 Mc, bandwidth at the 3 db point is 2 Kc and at 40 db 20 Kc. The insertion loss is 3 db. Exact dimensions are 0.80 by 0.675 by 0.780 in. Modular construction results not only in small sizes but also permits operation under rugged environmental conditions. Operational temperature range has been extended from −60C to +90C by using selected crystal cuts and temperature compensating components.

CIRCLE 330 ON READER SERVICE CARD



Coil Winding Machine

AUTOMATIC YOKE

ASSOCIATED AMERICAN WINDING MACHINERY, INC., 750 St. Ann's Ave., New York 56, N. Y., announces the model TVL59 coil winding machine. The width of each wire layer, as well as the number of layers desired, can be automatically adjusted as the wire is wound directly on the split core. Other features: automatic stopping of the traversing guide until the core is automatically indexed (between layers); automatic stop when the last layer is wound; quick change mechanism for rapid core changing; and a layer counter to indicate the number of layers already wound. The TVL59 will accept wire diameters from 0.006 to 0.020 in. for winding at the rate of 400 rpm. Maximum winding angle is 120 deg; minimum winding angle is 15 deg. Up to 12 layers of wire can be wound on a single core.

CIRCLE 331 ON READER SERVICE CARD

MANUFACTURING IS PART OF THE RELIABILITY PATTERN AT ELECTRO-TEC

Skilled hands, close attention to manufacturing techniques, quality control and a deep pride in a product well made...all are intrinsic to the reliability pattern at Electro-Tec. In the many stages between design and finished product, these factors are so balanced that desired component reliability becomes a reality every time. This mix of fine craftsmanship and unexcelled manufacturing capability is one of our most valued assets. ELECTRO-TEC CORP. South Hackensack, N. J. — Blacksburg, Va. — Ormond Beach, Fla.

DEPENDABLE SWITCHING

of contact loads to 25 amps . . .

"Diamond H" Series W Relays—The simple, functional construction of this high-quality general-purpose relay assures long-time dependable switching. For a broad range of applications, specifying "Diamond H" Series W Relays makes good sense. Here are some reasons:

Reliable—Mechanical life in excess of 10,000,000 cycles.

Versatile—a-c or d-c units available with choice of eight different combinations.

Compact—Measures 1½ x 1½ x 1⅞ inches—weighs less than 10 oz.

High Contact Rating—Conservatively rated up to 25 amps, 240 v a-c or 28 v d-c.

Easy to mount—Plug-in design. Panel or side mounts also available.

Underwriters Laboratory Approval—U/L File 31481.

Cost-saving—Low in initial cost, the Series W is easy to install, saves space, and is easy to service.

Send for complete facts—in new 8-page Series W Relay Guide.

THE HART MANUFACTURING COMPANY

202 Bartholomew Avenue, Hartford 1, Conn.

Phone JAckson 5-3491

Literature of the Week

DELAY LINES ESC Corp., 534 Bergen Boulevard, Palisades Park, N. J. A two color, illustrated brochure titled "Advancing the Art of Delay Lines" views the people, facilities, and products of the company.

CIRCLE 332 ON READER SERVICE CARD

INSTRUMENT SERVOS North Atlantic Industries, Inc., Terminal Drive, Plainview, N. Y. Two-color brochure SFC-1 describes instrument servos for measurement control, remote display, data conversion, and computation.

CIRCLE 333 ON READER SERVICE CARD

STATIC INVERTER Magnetic Research Corp., 3160 West El Segundo Boulevard, Hawthorne, Calif., has released specifications on its static d-c to a-c single-phase, sinewave inverter, model 90-156-0.

CIRCLE 334 ON READER SERVICE CARD

PRODUCTS CATALOG E. M. I. Electronics Ltd., Instrument Division, Hayes, Middlesex, England, has published an illustrated catalog covering a wide variety of its products. Included are scopes and cctv.

CIRCLE 335 ON READER SERVICE CARD

POWER ATTENUATORS Empire Devices, Inc., Amsterdam, N. Y. Bulletin 578 provides engineering data on two microwave power attenuators for the frequency range from d-c to 2,000 Mc.

CIRCLE 336 ON READER SERVICE CARD

DELAY LINE Deltime, Inc., 608 Fayette Ave., Mamaroneck, N. Y. A single catalog sheet describes type 192 magnetostrictive delay line, adaptable to computer, communications and military systems as a storage, memory or control device.

CIRCLE 337 ON READER SERVICE CARD

SEMICONDUCTOR BASES Standard Pressed Steel Co., Electronic Components Division, Jenkintown, Pa. A 4-page bulletin reviews the company's line of stud-mounted semiconductor bases and mating caps. Precision cold form-

Lb/min

Gal/hr

Ft/sec

RPM

Mach No.

Now you can read them all... directly, instantly with **Erie Instru/mation Model 740** Frequency Counter and Preset Translator

Model 740 is designed for monitoring any frequency to 120,000 cps and converting directly to physical units using standard transducers. One example is in **flow** calibration systems for engines or turbines where lb/sec or gal/min of flow is a requirement. Rate measurement applications include flow, linear velocity and production monitoring (articles or volume per unit time). Physical units of interest (e.g. lbs/hr) are displayed with in-line NIXIE readout. The Model 740 can also be used as a preset time interval generator and periodic or random event counter.

Modular construction, manual or automatic recycling and fine increment time base selection are other quality features that make the 740 an outstanding instrument. Write for complete technical information to:

ERIE Instru/mation

ERIE PACIFIC, DIVISION OF ERIE RESISTOR CORPORATION

12932 S. Weber Way

Hawthorne, California

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ing techniques and thread rolling, gaging and plating are explained.
CIRCLE 338 ON READER SERVICE CARD

SIGNAL GENERATOR Hewlett-Packard Co., Dymec Division, 395 Page Mill Road, Palo Alto, Calif. Single sheet describes the company's 250 mw X-band signal generators and 30 mw X-band test set.
CIRCLE 339 ON READER SERVICE CARD

POTENTIOMETER BROCHURE Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif., has published a four page brochure summarizing information on a line of Trimpot, Trimit, and Twinpot leadscrew and worm-gear actuated potentiometers.
CIRCLE 340 ON READER SERVICE CARD

C-C TELEVISION Television Utilities Corp., a division of Nord, New Hyde Park, L. I., N. Y. Features, applications, and specifications for a 27 in. video monitor and a 17 in. video monitor are available in separate data sheets.
CIRCLE 341 ON READER SERVICE CARD

MINIATURE CAPACITORS Efcon, Inc., Patterson Place, Roosevelt Field, Garden City, L. I., N. Y., has made available a booklet which describes the firm's polystyrene miniature capacitors, types PH and PC.
CIRCLE 342 ON READER SERVICE CARD

MICROCIRCUITRY Halex Inc., 310 E. Imperial Highway, El Segundo, Calif., has released a data sheet on the materials used in thin film integrated circuitry for use in microminiaturization of circuits.
CIRCLE 343 ON READER SERVICE CARD

DATA PROCESSING Walton Laboratories, Inc., 1186 Grove Street, Irvington 11, N. J., has made available a bulletin on humidification for data processing. It covers the role of temperature and relative humidity control in retaining the accuracy of computing machinery.
CIRCLE 344 ON READER SERVICE CARD

COMPUTER BLOCK Embree Electronics Corp., 993 Farmington Ave., West Hartford 7, Conn. A single data sheet gives specifications for a stabilized, operational, six-pack building block designed for a stored program analog computer.
CIRCLE 345 ON READER SERVICE CARD

OUTSTANDING

ERIE INSTRU/MATION

700 SERIES COUNTER-TIMERS

Here is a beautifully designed line of compact instruments of unusually high quality, performance and dependability for use in laboratories, original equipment and production lines where accurate measurement of events-per-unit time, period, or elapsed time is important. Operator-designed panels and in-line NIXIE readout assure positive, direct reading. Modular construction gives great flexibility and ease of maintenance and makes these instruments the most compact of any on the market. If you are looking for reliability, versatility and quality combined with reasonable price, the ERIE INSTRU/MATION 700 series of counter-timers deserves your serious consideration. Write for complete catalog to:

Model 740
FREQUENCY COUNTER & PRESET TRANSLATOR
for direct conversion from frequency to physical units

Model 720
FREQUENCY COUNTER
for events-per-unit time

Model 722
FREQUENCY-PERIOD COUNTER
combines frequency & period measurement

Model 723
TIME-INTERVAL COUNTER
for measurement of elapsed time between events

Model 724
PRESET RATIO COUNTER
1 to 10,000 times ratio of two input signals

Model 725
UNIVERSAL COUNTER-TIMER
precise measurement of frequency, period and time intervals

"QUALITY WHERE IT COUNTS"

ERIE

Instru/mation

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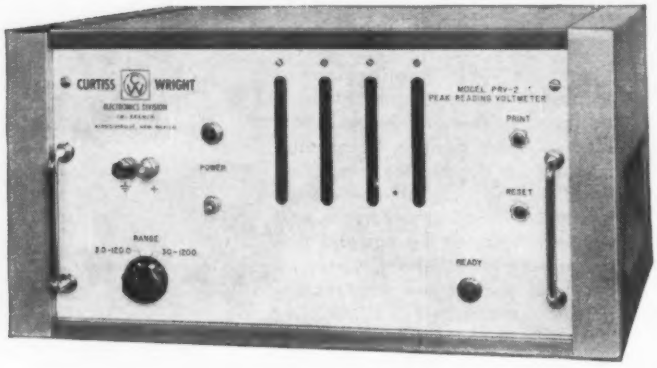
SINGLE TRANSIENT PEAK READING VOLTMETERS



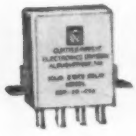
Model PRV-2 Single Transient Peak Reading Voltmeter. Approximate size, 10½" x 20" x 15¾". Weight, 55 pounds.

Read single transient pulses with 1% accuracy

The Curtiss-Wright Model PRV-2 Single Transient Peak Reading Voltmeter reads out the peak amplitude of rectangular pulses of 25 microseconds or greater rise time to an accuracy of 1%. Rate of fall required to initiate cycle is 0.2 volts per microsecond on the 1200-volt scale and 0.02 volts per microsecond on the 120-volt scale. Read-out is provided, directly in volts, as a 4-digit decimal value. The first peak voltage detected blocks further input values until reset.

You can use Model PRV-2 for peak pulse measurement wherever an oscilloscope would be too inconvenient—or too inaccurate. It is perfect for blast studies, shock studies, spherics measurements, to measure any transient phenomena which can be characterized by a voltage pulse. Input range: 3-120 volts @ 200 Kohm, 20 uuf input impedance; 30-1200 volts @ 2 megohm, 20 uuf input impedance. And, of course, the PRV-2 can be modified to accommodate a variety of input requirements.

Write us about your needs.



SOLID STATE RELAYS for microsecond switching applications. Extremely resistant to high shock and vibration environments.

Inter Mountain Instrument Branch—Electronics Division

CURTISS WRIGHT

CORPORATION • P.O. Box 8324, Albuquerque, New Mexico

SOLID STATE RELAYS • SINGLE TRANSIENT PEAK READING VOLTMETERS • TRANSISTOR TEST INSTRUMENTS AND SYSTEMS • DIGITAL DATA ACQUISITION AND PROCESSING SYSTEMS

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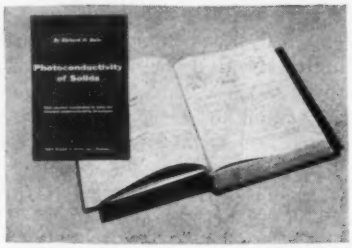
NEW BOOKS



Photoconductivity of Solids

By RICHARD H. BUBE

John Wiley and Sons, Inc., New York, 1960, 461 *p*, $14.75

A detailed, comprehensive survey of photoconductivity, this book, written on the graduate level, is well suited for the design engineer who wishes to become more familiar with this important field of solid-state electronics. After a brief historical survey, the author describes the necessary background in solid-state physics and crystal structure and from there goes on to the basic mechanisms of photoconductivity, the methods of producing photoconductive materials and other practical aspects.

An interesting chapter lists and analyzes the current theories of photoconductivity. The final chapter covers related topics such as surface photoeffects, noise considerations and photoconductivity in silver halide photography.

A brief appendix gives a survey of practical applications of photoconductive principles. From the engineer's point of view this part might have been more detailed and tied closer to the theory, though this would be a difficult task in view of the scope and pace of present solid-state developments. G.V.N.

Introduction a L'Etude des Systemes Asservis

By L. CHARIN

Dunod, Paris, 147 *P*, 960 *Fr.*

THIS book is an introduction to the study of automation systems. Notions of gain, phase, curve of

response and broad band are essential in solving problems of stability in these systems.

The theoretical part of the book presents two experimental models of electronic amplifiers with construction and test data. In the first model the author presents the theoretical part in the simple, numerical and real case, and tries to realize a junction between classical and modern methods. In the second model the author shows the complexity of research on a stability corrector of an automation system. The degree of stability by the curve of Nyquist-Cauchy is given; however, practical methods for analysis and synthesis of mechanical and electro-mechanical systems are not.

The mathematical treatment is kept simple and the book is addressed especially to the engineers, practicians, technicians and students who are involved in the study of automation systems and servomechanisms and who want to know, without complex mathematical analysis, the operational and logical calculations required to solve the problems of servomechanisms in the laboratory or factory.—DR. A. KIRILOFF, *Electronics Research Laboratories, Columbia University, New York.*

Space Flight, Vol. I: Environment and Celestial Mechanics

By KRAFFT A. EHRICKE

D. Van Nostrand Co., Inc., N. J., 1960, 513 *p*, $14.50.

THIS REVIEW is devoted to the first volume of a three-volume series entitled *Principles of Guided Missile Design*. As stated by the author, Space Flight is written for serious students of astronautics, that is, engineers and scientists from industry as well as from the academic world. This first volume is in two sections: part I, environment and part II, celestial mechanics.

Part I contains three chapters. Chapter I gives an enlightening historical development of the concept and techniques of space flight

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DEPENDABILITY
is a prime
requisite
PRESS-FIT®
TEFLON
TERMINALS
Sealectro Press-Fit Teflon Insulated Terminals, Feed-Throughs, and Test Jacks assure maximum dependability under all operational conditions. Designs resulting from unparalleled experience, careful fabrication from the finest materials, and precise inspection combine to make Sealectro Press-Fit units first choice for quality and value...
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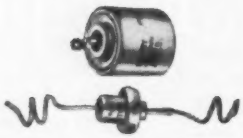
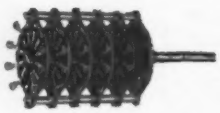
Immediate delivery at factory prices... from Mallory industrial



TANTALUM CAPACITORS Industry's broadest line. Microminiature to high capacity: 0.33 to 1300 mfd. Sintered wet slug, solid and foil types. Temperature ratings —55 to +200°C.



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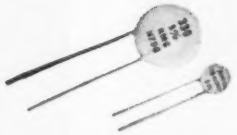

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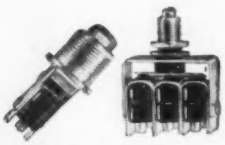

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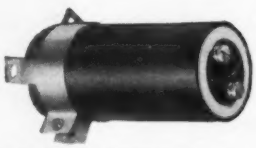

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as well as its future implications. Chapter 2 presents fundamental questions pertaining to the feasibility of space flight with emphasis on energy requirements. Chapter 3 furnishes a good deal of physical data on the constituents of the solar system and their environment. Such data include measured values of the gravitational and magnetic fields, of the earth's radiation belt intensity, and of meteor orbits and sizes.

Chapter 4 is the first chapter of Part II. This chapter analyzes motion in a central force field, that is, in a gravitational field created by a mass point or a sphere. Chapter 5 deals with the computation of orbit parameters for the purpose of predicting the position of a space vehicle for tracking or data acquisition. Chapter 6 presents computational methods useful in dealing with the motion of a body in a noncentral force field.

The book contains a comprehensive list of references. It is particularly suited for researchers and engineers from other fields who are engaged in astronautics, since the book will provide them with the necessary foundation to advance the science and technology of space flight.—H. HODARA, *Head of Space Communications Developments Div., The Hallicrafters Co., Chicago, Ill.*

THUMBNAIL REVIEWS

Principles of Feedback Control. By C. H. Wilts, Addison-Wesley Publishing Co., Reading, Mass. 1960, 265 p, $8.75. A thorough, rigorous treatment of the analytical methods of feedback system design, written on the senior and graduate student level. This work is a textbook rather than a handbook, and contains numerous problems. The main theme is the stability problem; the Routh-Hurwitz and the Nyquist criteria are covered in detail, as is the concept of a root locus and the problem of relative stability. Since the subject is by necessity a highly mathematical one, some of the necessary techniques are explained; however, a knowledge of Laplace transforms and their use is desirable.

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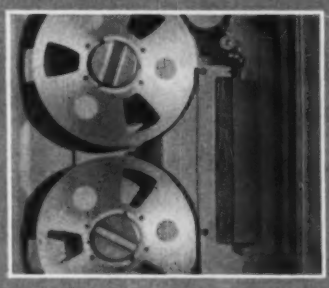

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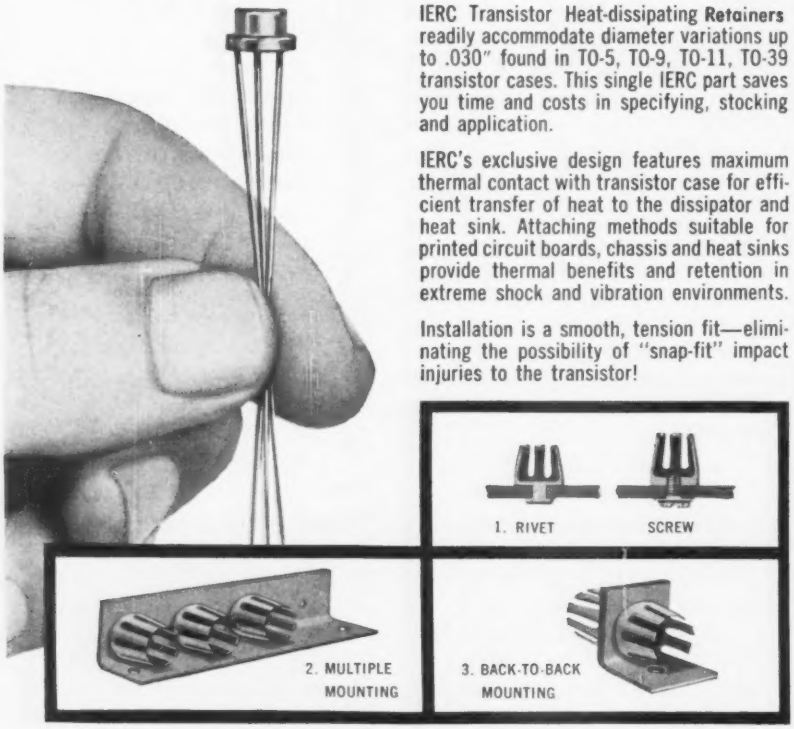

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International Missile and Spacecraft Guide. By Frederick I. Ordway III and Ronald C. Wakeford, McGraw-Hill Book Co., Inc., New York, 1960, 403 p, $25. Here is a well-organized, encyclopedic presentation of facts, data and background on both military and nonmilitary rockets, missiles and spacecraft of the world. Illustrated with 861 photographs, drawings and diagrams, the guide includes a chronology of missile progress beginning with the year 1200, an exhaustive listing of world-wide organizations—civilian and government—concerned with any phase of missile and spacecraft activity, and descriptions of all known vehicles, one by one, country by country. The authors' comprehensive knowledge of their vast subject enabled them to put individual vehicles into context by describing their family affiliation and objectives.

Presentations of the many objectives in the world's space effort include not only reports on progress to date, but descriptions of techniques being used, where particular problem areas lie, the associated ground equipment being used and the major companies doing the work. Electronic equipment and techniques are treated extensively.

General Electric Transistor Manual. Fifth Edition. Edited by Semiconductor Products Dept., G. E., Liverpool, New York, 1960, 329 p, $1. This excellent transistor manual has been further improved by the addition of new sections on tunnel diode theory and applications, feedback and servo amplifiers, and transistor test circuits. The specification tables have been brought up to date with new transistors and tunnel diodes.

Silicon Carbide—A High Temperature Semiconductor. Edited by J. R. O'Connor and J. Smiltens, Pergamon Press Inc., New York, N. Y., 521 p, $12.50. Proceedings of the Conference on Silicon Carbide sponsored in 1959 by the Electronics Research Directorate, Air Force Cambridge Research Center. The papers report on studies of the materials, single crystal growth, physical and electrical properties, radiation effects and the fabrication and characteristics of silicon carbide devices.

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5	21	37	53	69	85	101	117	133	149	165	181	197	213	229	245	261	277	293	309	325	341	357	373
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Key No. **R-19b**	**Medical Electronics — Part II: Diagnostic Systems and Visualization**	6	Feb. 3, 1961	25¢ each

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—eliminates the old bugaboo of cable entanglement which damages tubes and components in lower chassis each time the one above is withdrawn for service and returned to position.

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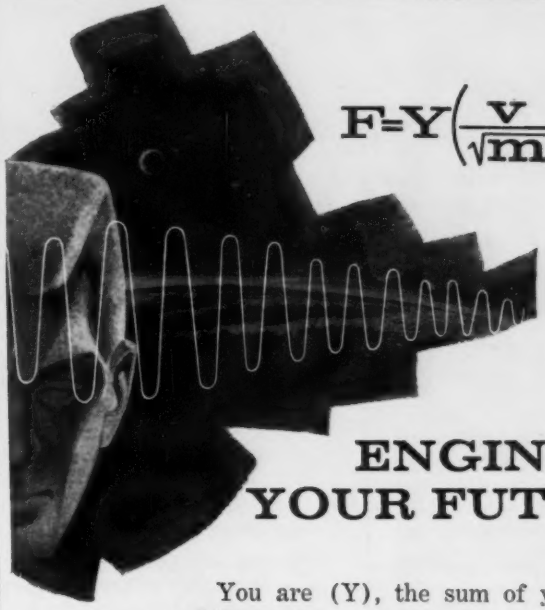

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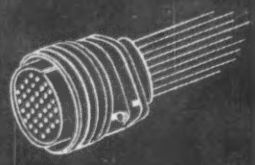
BENDIX MS-R

ENVIRONMENT RESISTANT

Connectors



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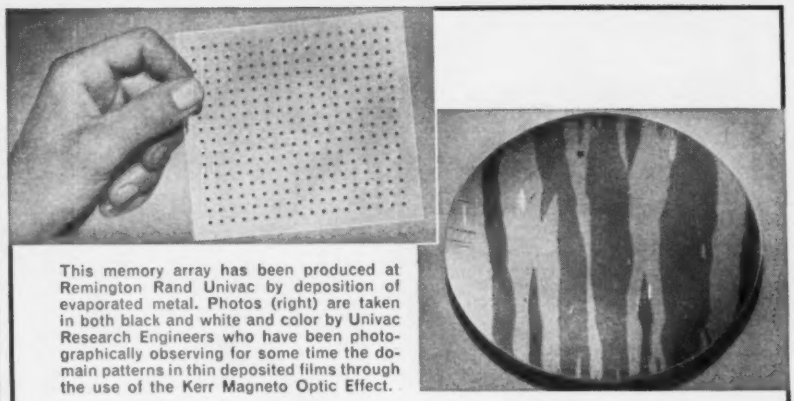

This memory array has been produced at Remington Rand Univac by deposition of evaporated metal. Photos (right) are taken in both black and white and color by Univac Research Engineers who have been photographically observing for some time the domain patterns in thin deposited films through the use of the Kerr Magneto Optic Effect.

Univac now has a number of opportunities for participation in exceptionally interesting projects which offer both professional and personal reward. These positions are significant in their potential for advancement.

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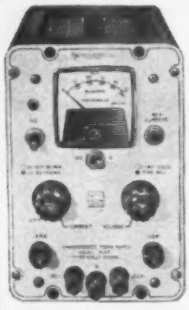

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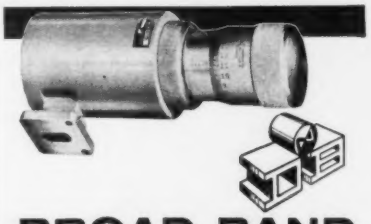

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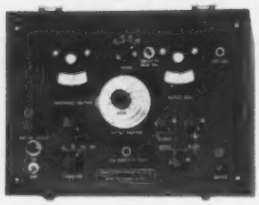

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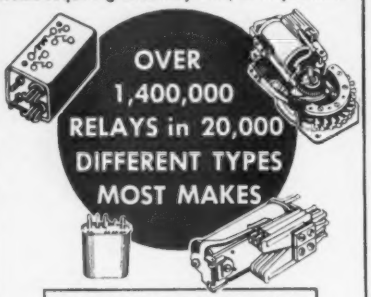

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Speeds Production, Saves Extra Operations on Chassis Work

"I use our Di-Acro Notcher for practically everything," says V. Johnson of Maico Co., Inc., Minneapolis manufacturer of hearing testing equipment. "This machine speeds production—*provides one operation notching* of cold rolled steel, brass, phosphorous bronze and aluminum up to 16 gauge thick. It's also used for notching fish paper, sponge rubber, 1/16" linen Bakelite and other circuit insulating materials that go into chassis for audio testing equipment."

The 4 ton pressure of this machine has the capacity to cut a 90° notch as large as 6"x6" in 16 gauge steel *in one operation.* Adjustable gauges mounted on work table are standard. Hardened and ground triangular ram assures years of precision. A clean cut, free from rough edges and burrs, is possible because blade clearance can be easily set. For high speed production, a power model is available.

Di-Acro Notcher is used on the open end of this .064" aluminum chassis at Maico Co., Inc.

Consult the Yellow Pages of your phone book under Machinery, Machine Tools for the name of your nearest Di-Acro distributor or write us for Quick Facts Folder describing this and other Di-Acro machines

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Mr. Robert A. Martin, Supervisor, Scientific Employment
HUGHES AEROSPACE ENGINEERING DIVISION
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I have had a total of_____years experience.

Wiesner: once upon a dinosaur . . .

TAKE A LESSON from the dinosaur, says communications authority Jerome B. Wiesner, 45-year-old special assistant to President Kennedy for science and technology.

The dinosaur had a poor communications system, and maybe that's why he became extinct. When a dinosaur got a whack on the tail from another creature, there was no microsecond response.

Dr. Wiesner's interests in communications cover a wide range—from electronic engineering to the toughest of communications problems.

Professor of electrical engineering and director of the Research Laboratory of Electronics at MIT before taking his Washington post, Wiesner headed establishment of the MIT Center for Communication Sciences, an interdepartmental activity for study of communications processes in both manmade and natural systems. The center cuts across a dozen scientific disciplines and includes on its roster experts on information theory, language, psychology, biophysics and electronic circuits.

Wiesner, a soft-spoken, almost casual man in conversation, is described by one of his closest friends in the scientific community as a "scrapper" when the chips are down. "He'll fight to the wall when it's a matter of principle."

"Jerry is also a gap-filler," says a noted physicist. "If there's an area of technology which he thinks is not being adequately explored, he'll jump in to fill the gap. So, I wouldn't be surprised to see him in his new job pounce on what he considers a neglected field, e.g., the national problem of transportation, and tackle its scientific aspects."

But numerous roles as government defense adviser have channeled Wiesner's thinking in recent years principally to the problem of bringing the world arms race under control before man blows himself up. He is deeply and personally concerned with disarmament, as was evident when he addressed the Northeast Electronics Research and Engineering Meeting in Boston last Fall, repeatedly citing the "very unstable security from the arms race."

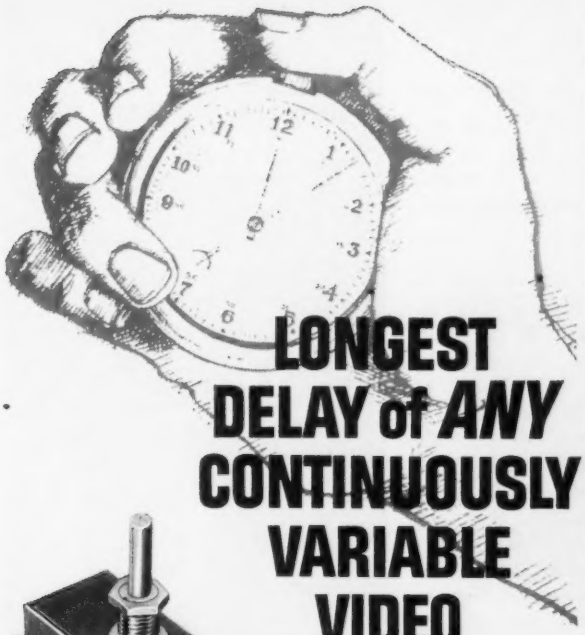
Wiesner, a native of Dearborn, Mich., spent his youth in Detroit where he confounded utility people with his private telephone network he built for neighborhood communication with his young friends. He received degrees in electrical engineering and mathematics from the University of Michigan. After working on electronic techniques for speech correction, he was chief engineer of the Acoustical and Record Library of the Library of Congress. Shortly after World War II started, he joined the MIT Radiation Laboratory in the radio frequency development group. He spent a year at the Los Alamos Laboratory on electronic instrumentation for atom bomb tests before returning to MIT. He was a member of President Eisenhower's Science Advisory Committee and was staff director of the American delegation to the 1958 Geneva Conference on prevention of surprise attack. He was a member of the committee which prepared the Gaither Report and was a participant in the 1960 Pugwash Conference.

He is a fellow of the IRE and of the American Academy of Sciences, a member of the National Academy of Sciences and of the Acoustical Society of America. He is a member of the steering committee of MIT Lincoln Laboratory and helped develop scatter communications techniques for Sage.

Wiesner loves reading of all kinds, likes sailing, swimming, amateur photography, recordings of folk music—and cooking breakfast for the family on quiet Sunday mornings in the Watertown, Mass., home where he lives with his wife, four children and his mother. He is also interested in books for the blind, is chairman of the technical committee of the American Foundation for the Blind.

Solid State Materials Names Board Member

RICHARD B. ADLER, professor of electrical engineering at MIT, was recently named to the board of



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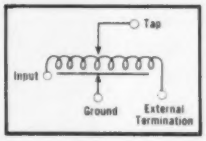

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503	4.0 usec.	220	.80 usec.	2.5 db
504	9.0 usec.	100	1.8 usec.	5.0 db
505	15.0 usec.	56	3.0 usec.	9.0 db

*Rise time is proportional to delay

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February 17, 1961

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Impedance	50 ohms,	50 ohms
V.S.W.R.	≦1.2 in pass band, consistent with peak to valley ratio	
Insertion loss	≦1 db	≦1 db
Peak to valley ratio	≦.5 db	≦.5 db
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Power rating	25 watts	100 watts
Connectors	BNC or Type N	BNC or Type N

Bandpass filters with other bandwiths, power ratings, etc., are available on special order. Also available — a wide variety of tunable filters.

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directors of Solid State Materials Corp., East Natick, Mass. His major interests have been in circuit theory, electromagnetic theory, and semiconductor electronics.

Shockley Transistor Hires Veltfort

APPOINTMENT of T. E. Veltfort, Jr., as chief electronics engineer for Shockley Transistor, Palo Alto, Calif., is announced.

Veltfort brings to Shockley a wide experience in transistorized electronic systems. He recently served as a consultant to Moore Associates in San Carlos, was senior project engineer with Lynch Communications Systems, Inc. of San Francisco, and before this, he was chief development engineer for the electrical division of Shand and Jurs in Berkeley.

CircuitDyne Elects Board Chairman

MORTON ALPERIN, a leading figure in the advancement of space technology, has been elected chairman of the board of the recently-formed CircuitDyne Corp., Pasadena, Calif.

Alperin was formerly technical director and president of Space Systems and Industrial Automation, a subsidiary of Idaho Maryland Industries in Studio City.

Hughes Aircraft Appoints Carr

ROBERT E. CARR has been named manager of rectifier operations for Hughes Aircraft Company's semiconductor division, Newport Beach, Calif. He will direct development and production of a complete line of advanced medium power recti-

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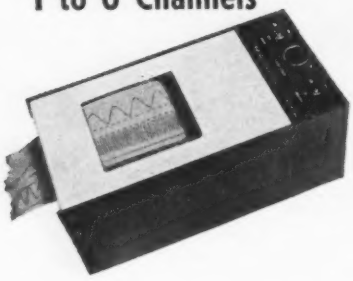
Direct Writing Light Beam Oscillograph

1 to 6 Channels



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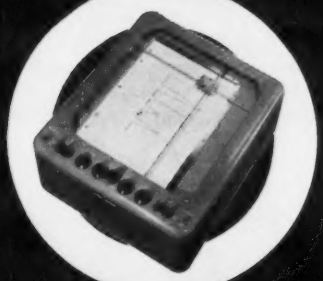
XY [GRAPH] RECORDER



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- 10 k or potentiometric input
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fiers with military-approved specifications as part of an overall technical program emphasizing silicon rectifier product stability, reliability and competitive pricing.

Before joining Hughes, Carr worked in General Electric's advanced development projects and rectifier department.

Gabriel Electronics Hires Chief Engineer

DAVID FALES III has been named chief engineer of Gabriel Electronics, Millis, Mass., division of The Gabriel Co. He was formerly manager of electronic product sales and staff engineer for the Martin Co. in Baltimore, Md.

In his new post, Fales will be responsible for new design concepts and research and development in all phases of electronics with emphasis on microwave propagation.

Control Data Names Product Manager

CLAUDE T. GURLEY has been appointed product manager for data collection and processing systems manufactured by Control Data Corp., Minneapolis, Minn.

Until recently he was head of the data processing division of U. S. Naval Weapons Plant of Washington, D. C.

Jettron Announces Expanded Facilities

KENNETH JOHNSEN, president of Jettron Products, Inc., announces the recent opening of new facilities at its present location in Hanover, N. J. The addition will house the company's increased administra-

New ULTRAgraph 440

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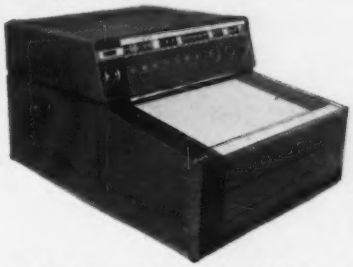

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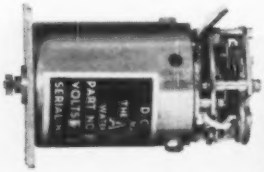

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tion, sales, and engineering force. It will also provide the extra space required by the expanded manufacturing staff.

Jettron supplies hundreds of commercial, industrial, and military accounts with special sockets and connectors for the electronics field. The firm also makes high reliability sockets for semiconductors.

Electra-Mech Names Chief Engineer

ANTHONY L. LICCARDI has been appointed chief engineer for Electro-Mech Corp., Norwood, N. J. In his new capacity, he will direct all engineering personnel involved in the design of the company's industrial control systems, as well as the engineering group associated with their reliance instrument division, which manufactures a complete line of electronic combustion controls.

Prior to joining Electro-Mech, Liccardi was in charge of controls and instrumentation for the Loewy Hydropress Division of Baldwin Lima Hamilton Corp., where he was chiefly responsible for the design and development of the first control systems for the moving Polaris missile launcher.

Harman-Kardon Opens New L.I. Plant

HARMAN-KARDON recently opened a new 52,000 sq ft electronics plant in Engineers Hill, a 41-acre industrial community in Plainview, L. I., N. Y. Company produces advanced stereophonic high fidelity components and micromodule logic elements for industrial and military computers.

Harman-Kardon now employs about 400 people. The new plant,

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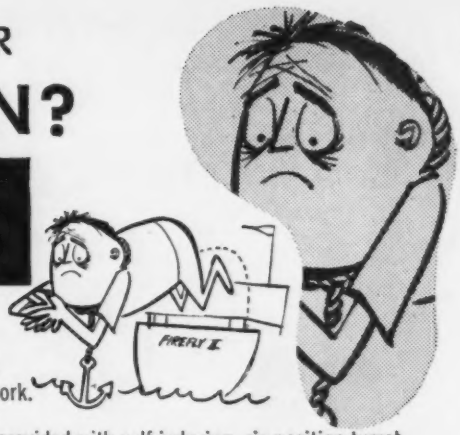

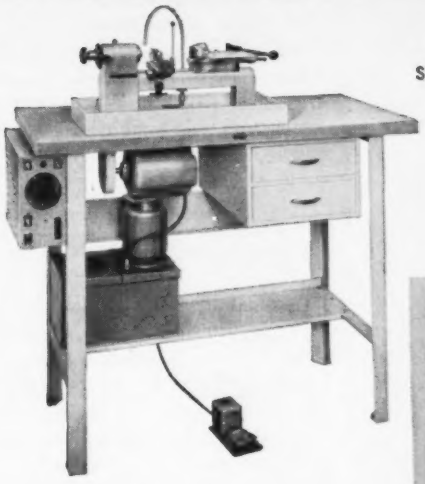

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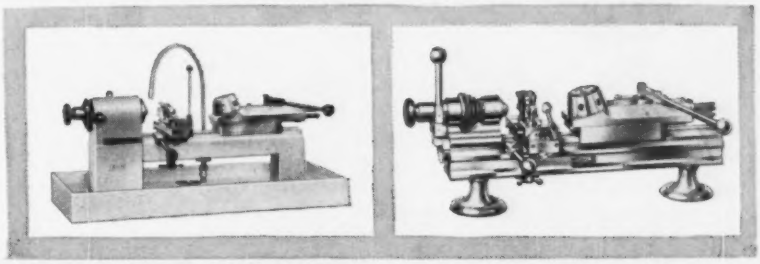

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NYT Manufacturing Advances Zernick

MARTIN E. ZERNICK has been named vice president and general manager of NYT Manufacturing Co., Inc., with plants at Phillipsburg and Alpha, N. J.

Prior to joining the company in 1958, he was employed by the General Electric Co.

PEOPLE IN BRIEF

F. W. Gutzwiller appointed manager of application engineering for the General Electric rectifier components dept. **L. Edward Godycki,** formerly with IBM Research Labs, joins Electro-Optical Systems as senior research physicist, solid state division. **Alfred J. Wheeler,** ex-RCA, named device development engineer at Micro State Electronics. **R. Bruce Large,** from Hughes Aircraft, chosen as executive vice president and general manager of Networks Electronic Corp. **Warren N. Arnquist,** formerly with the System Development Corp., appointed assistant to the director of advanced research at Douglas Aircraft. **Burl H. Ervin** advances at Northrop Corp., Nortronics Div., to director of applications engineering for the systems support dept. **Harry B. Miller** leaves Clevite Research to join Stromberg-Carlson as manager of the electroacoustics advanced development lab, electronics division. **Harold W. Bigelow** from Westinghouse Electric named midwest district sales manager for the semiconductor division of Syntron Co. **Rudolph G. E. Hutter** of Sylvania Electric Products promoted to chief engineer of the microwave device operations, electronic tube division. **Edward L. Falls, Jr.** named general manager of Motorola Aviation Electronics, Inc. **Matthew D. Krim** and **Frederick B. Mangel, also of** Motorola, have taken posts as product administrators and staff assistants to Edward Falls.

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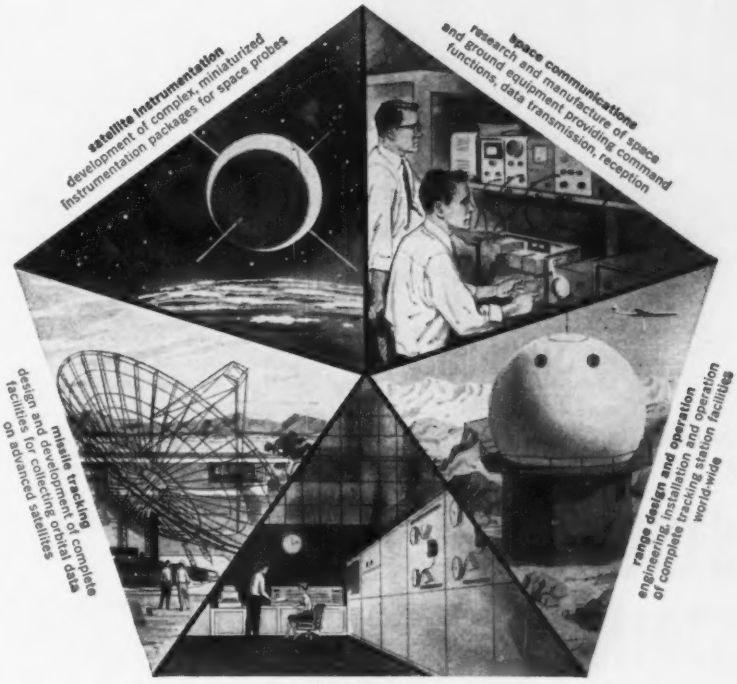
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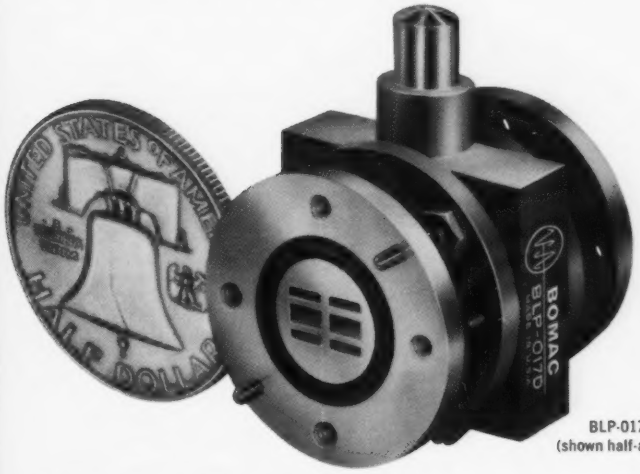

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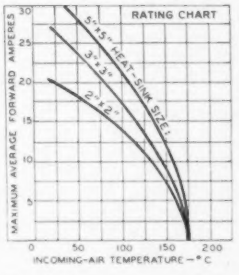
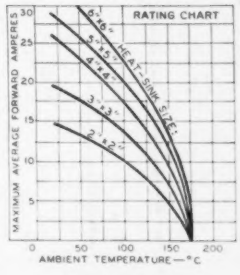
1N249C	110	20	350	3.6	0.6
1N250C	220	20	350	3.4	0.6
1N1195A	300	20	350	3.2	0.6
1N1196A	400	20	350	2.5	0.6
1N1197A	500	20	350	2.2	0.6
1N1198A	600	20	350	1.5	0.6

▲ For One-Half Cycle.
• For 60 cps, single-phase operation, resistive or inductive load.
■ At Maximum Forward Current and Peak Inverse Voltage Ratings, and averaged over one complete cycle.

Reverse-Polarity Versions: 1N248RC, 2N249RC, 1N250RC, 1N1195RA, 1N1196RA 1N1197RA, 1N1198RA



Forced-air cooling: Air velocity = 1000 feet per minute parallel to plane of heat sink. Single-phase operation. Rectifier type is stud-mounted directly on heat sink. Heat sink: 1/16"-thick copper with a mat black surface and thermal emissivity of 0.9.



Natural cooling. Single-phase operation. Rectifier type is stud-mounted directly on heat sink. Heat sink: 1/16"-thick copper with a mat black surface and thermal emissivity of 0.9.

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